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THE WORLD'S COLUMBIAN EXPOSITION—THE FRENCH NATIONAL HOLIDAY.

CHICAGO, July 20, 1893.

THE French national holiday of the 14th of July afforded to the Frenchmen who were present at the Fair an opportunity of making a very imposing and patriotic manifestation. Our engraving is from *Monde Illustre*. It shows the French pavilion specially decorated for the occasion. During the afternoon a garden party was brought together consisting of members of Chicago society, the managers of the Exposition, the exhibitors, the French consular corps and some members of the French colony. A well furnished buffet had been provided and the band played without interruption from the beginning to the end of the *fete*. The absence of the general commissioners, Messrs. Krantz and Roger Ballu, was very much regretted, but the consul general, M. Bruwaert, was present.

The honors of the day are due to M. Leblanc Barbedienne, who had, by cable, instructed his Chicago representatives, in case the 14th of July should be celebrated, not to forget the firemen killed at the fire which occurred on the Fair grounds July 10. The decoration of the French pavilion was very fine. At the entrance of the Lafayette Hall the bronze bust of M. Carnot was placed, behind which could be seen the "Gloria Victis" of M. Mercie.

This beautiful group was surrounded with French

THE WORLD'S COLUMBIAN EXPOSITION—THE FRENCH PAVILION AS IT APPEARED ON THE NATIONAL HOLIDAY.

and American flags, to which were added as noble trophies fire engine hose and a fireman's ax and helmet.

France has liberally contributed to the subscription in behalf of the victims of the recent catastrophe, and has proved once more by the magnificent artistic manifestation of M. Leblanc Barbedienne that her heart is always full of sympathy for those who suffer, and that she always honors the victims of duty.

The Frenchmen residing in Chicago have thanked M. Barbedienne for the support he has so generously lent for the celebration of the 14th of July. The throng of Americans who constantly passed before the national pavilion eagerly applauded the homage paid to the victims of the catastrophe.—*Frederic Mayer; Le Monde Illustre.*

THE WORLD'S COLUMBIAN EXPOSITION—THE INTERNATIONAL ZOOLOGICAL CONGRESS.

PROBLEMS OF ZOOLOGY.*

LADIES AND GENTLEMEN: Let me assure you that I am not unmindful of the favor shown in electing me to open this International Congress of Zoologists.

Thirty years have nearly passed since I had the pleasure—as a then resident of this bustling city of Chicago—of listening to a series of lectures on zoology by Louis Agassiz; and as I recall the popular interest and enthusiasm which the great master inspired, and the singular activity and devotion of Kennicott, Stimpson, and others of Chicago's earlier zoologists, I am led to hope for a renewal of that early spirit and enthusiasm as a result of your meeting here.

Zoology, but a few years back, dealt chiefly with the habits, structure and classification of animals, and was weighted with two prevalent fallacies which theology had so generally impressed on the human mind. These were the Biblical idea of the creation of organisms as they now exist and their consequent fixity and the homoistic notion that man was, in physical as well as psychical endowment, apart from and not a part of the rest of the animal world. Released from the oppressive incubus of these long-cherished fetiches, zoology has during the past quarter of a century bounded into the front rank of the sciences, with so many of which she is so intimately bound.

Inspired and guided by the search light of evolution, which reveals and makes intelligent so much that was hidden or unmeaning before, zoology must lead her sister sciences in all study of the genesis of life upon our planet, whether in past or present time. With the induction of the unity of all psychic phenomena, and the conviction that these are inseparable from animal organization, it is her mission to give rational explanation of the subtilest of such phenomena, and to check the vagaries which exist as to their abnormal manifestations; for even among lower animals there are senses and sense organs not yet understood by us, while some species have developed a telepathy which, in its power and ease of demonstration, may well astonish those who have hitherto confined their investigations to man.

Deeper study of electricity, as exemplified in the animal world, may help the electrician to a better understanding of the nature of that force, the practical application of which to the affairs of civilized man has made such gigantic strides of late; while animal phosphorescence may yet illumine, when better understood, the path of the physicist in his investigations of the phenomena of light. Animal mechanics, as exhibited in flight, may hold the solution of practical aeronautics, which promises to cap the marvelous and momentous discoveries of the century; while to the inventor they are pregnant with yet untold and unthought-of suggestions.

That branch of zoology which concerns the interrelations and interactions of animals is not only fascinating to the philosophic student, but has a most important economic bearing, especially to those engaged in agricultural and horticultural pursuits.

But the subject which just now seems to be receiving most attention from zoologists is heredity, and the cognate question, which has divided us into two opposing camps, as to whether or not characters and functions acquired during the lifetime of the individual are transmitted to the offspring. The solid fabric which Darwin did so much to erect, and which is essentially based on the affirmative proposition, has been most persistently stormed, especially by a certain class of embryologists, and the question is too complicated and far-reaching to be lightly considered. It may be well to bear in mind, however, that the solution of the problem involves the psychical as well as the physical facts, and that the former cannot be revealed by scalpel or microscope. The naturalist who studies the development, *ex ovo*, and the actions of living organisms, in their relations to each other and to their environment, and who seeks to confirm his views by experimentation, is, in my judgment, better qualified to draw reliable conclusions than either the histologist or the embryologist. Modern laboratory methods of zoological work, encouraged by the importance of bacteriology, have been so generally influenced by the microscope that they have pushed beyond the shore line of safe induction, and we already hear the murmurings of the reactionary wave which will carry us back toward the more comprehensive methods of the older school of naturalists whose names adorn the annals of our science. The microscope, however important in revealing the processes of growth, will yield us the secret of heredity no sooner than it will yield us the secret of life itself!

The latent potentiality contained in the germ, and the psychological directing force which modifies in later development, must always escape such methods. What we now most need to establish any sound theory of heredity is experimentation, intelligently planned and carried on through a series of years, not alone during embryonic, but during the whole development of the individual, and to include all the elements in the problem. Such experimentation on a sufficiently broad scale can hardly be undertaken by individuals, and the institution which will liberally endow and equip a chair of experimental zoology to this end will deserve well of mankind. The zoologist, while skeptical of the ordinary theological and metaphysical interpretations of mind phenomena, is not disposed to dogmatize. His attitude is one of agnosticism on all questions as to the origin, nature and end of life, whether in its simpler or more complex manifestations, and he simply insists with Wordsworth that "to the solid ground of nature trusts the mind which builds for aye!"

The subdivisions of our science in which just now investigation is most active are those which shed light on the general subject of animal evolution, and our programme shows that paleontology, embryology, kinetogenesis, bioplastology, heredity and kindred subjects will not lack for eminent exponents. It would be unwise to delay proceeding with such an interesting problem by further remarks of my own, and I will at once call for the reading and discussion of the formal papers.

* Remarks made at the opening of the International Zoological Congress, Chicago, August 19, 1893, by Dr. C. V. Riley, of Washington, D. C., as honorary chairman.

[Continued from SUPPLEMENT, No. 934, page 14769.]

THEORIES OF THE ORIGIN OF MOUNTAIN RANGES.*

By Prof. JOSEPH LE CONTE, the retiring President.

SUMMARY STATEMENT OF THE FORMAL THEORY.

WE may, therefore, group all these inferences and sum up our view of the mode of mountain formation thus:

1. Mountain ranges, while in preparation for future birth, were marginal sea bottoms receiving abundant sediment from an adjacent land mass and slowly subsiding under the increasing weight. 2. They were at first formed and continued for a time to grow, by lateral pressure crushing and folding the strata together horizontally, and swelling them up vertically along a certain line of easiest yielding. 3. That this line of easiest yielding is determined by the hydrothermal softening of the earth's crust along the line of thickest sedimentation. 4. That this line, by softening, becomes also the line of greatest metamorphism; and by yielding, the line of greatest folding and greatest elevation. But (5) when the softening is very great sometimes the harder lateral strata are jammed in under the crest, giving rise to fan structure, in which case the most complex foldings may be near but not at the crest. Finally (6), the mountains thus formed will be asymmetric, because the sedimentary cylinder lenses from which they originated were asymmetric.

SOME EXAMPLES ILLUSTRATING.

It is hardly necessary to enforce these views by illustrative examples. They at once arise in the mind of every geologist. But there are those in this audience who are not geologists. I therefore select a few examples among our own mountains.

1. *Appalachian.*—It is well known that during the whole Palæozoic the region now occupied by the Appalachian was the eastern marginal bottom of the great interior Palæozoic sea, receiving abundant sediments from an eastern land mass of Archæan rocks, which then extended far beyond the present limits of the continent, and whose western coast line was a little to the east of the present Appalachian crest. The sediments along this marginal sea bottom increased in thickness during Cambrian, Silurian, Devonian and Carboniferous (with some changes of physical geography, but without greatly changing the line of sedimentation) until 40,000 ft. thickness was reached. Such thickness, of course, could not be attained without *pari passu* subsidence. We have additional evidence of this in shallow water fossils, and even shore marks at many levels in the series. At the end of the coal period, when 40,000 ft. had accumulated, the increasing softening along the line caused it finally to yield to horizontal thrust; the whole mass of strata was crumpled together and swelled up along the line of sedimentation, and the Appalachian range was born. The same forces which caused its birth continued to cause its *growth* for a long time. Subsequent erosion has sculptured it into its present form, but has *not exposed its granite core.* The crest is on the east or landward side, as we should expect, and the overfolds are to west or toward the sea of that time. This is perhaps the most typical example we have.

2. *Sierra.*—If it were not for a subsequent movement so late as the beginning of the Quaternary, which greatly modified its form, the Sierra, too, would be a typical range. During the whole Palæozoic and the greater part of the Mesozoic the place now occupied by the Sierra was the eastern marginal bottom of the Pacific receiving sediments from a continental land mass in the present basin region. The shore line changed somewhat at the end of the Palæozoic, but the Sierra region maintained a sea bottom position. At the end of the Jura, when an enormous thickness had accumulated, the increasing softening of the crust determined a yielding to lateral thrust and consequent formation of the range. Subsequent erosion has completely removed the strata from the crest and exposed the granitic core as an axis.† This axis is here also on the landward side, and the overfolds are to the seaward as in the Appalachian. The erosion of the Cretaceous and Tertiary times probably cut down the Sierra to very moderate proportions and reduced it to an almost senile condition. At the end of the Tertiary a great fault and bodily uplift of the whole Sierra block on its east side transferred its crest to the extreme eastern margin, greatly increasing its height and rejuvenating its erosive vigor.

3. *Coast Range.*—The formation of the Sierra transferred the coast line westward of that range, and the present place of Coast Range became the marginal sea bottom, receiving sediment from a now greatly reduced land mass. This continued until the end of the Miocene, when the Coast Range was similarly formed.

We might multiply examples, but these are deemed sufficient to illustrate the principles.

* Annual address before the American Association for the Advancement of Science, at the Madison meeting, August, 1893.

† Sierra granite is not Archæan, as has been asserted by some, nor does it all antedate the birth of the range. This is proved (1) by the gradation traceable between the slates and granites, and (2) by the fact stated by Whitney, by Fairbanks and by Diller, that the granite in many places penetrates the slate as veins.

MINOR PHENOMENA.

We have given only the most fundamental phenomena, *i. e.*, those which reveal the mode of origin, and upon which, therefore, a true theory must be founded. But all other minor phenomena associated with mountains are well explained by the view above presented, and their explanation confirms the view. For example:

1. *Eruptive Phenomena.*—We have seen that beneath a mountain before and at the time of its formation there is a deep-seated core of liquid or semi-liquid matter. Also it is evident that the strong foldings of the strata in the act of formation must produce fissures parallel to the folds and to the mountain axis, and that these fissures may reach down to the sub-mountain liquid matter. In the act of mountain formation, therefore, the sub-mountain liquid must be squeezed into the fissures, forming dikes, or through the fissures, and poured out on the surface as great lava floods, covering sometimes thousands of square miles. In most cases subsequent erosion has swept these overflows clean away, leaving only their roots as intersecting dikes. Only the most recent still remain. On these great fissure eruption lava fields ordinary volcanic or crater eruptions continue for ages after the mountain formation ceases. In these, however, materials are ejected not by mountain-making forces, but by the elastic force of vapor from percolating waters. All these eruptive phenomena are, therefore, associated with mountain ranges.

2. *Faults.*—In folding, and especially overfolding, the strata are, of course, often broken and the upper wall of the fissure is pushed over the lower wall by horizontal thrust, often thousands of feet, forming reverse faults and so-called thrust planes. Hence this style of faults are everywhere associated with strongly folded rocks, and, therefore, with mountains, and are indisputable evidence of horizontal crushing. In other places than mountains, and in horizontal or gently folded rocks, the other style of faults, *i. e.*, normal faults, are more common.

3. *Mineral Veins.*—The filling of fissures at the moment of formation with fused matter constitutes dikes; but if not so filled, they are afterward filled by a slow process of deposit from circulating waters, and then they form mineral veins. These, therefore, are also common in mountains.

4. *Earthquakes.*—Again, the immense dislocations of strata which we find in faults did not occur all at once, but slowly through great lapse of time; and yet, on the other hand, not by uniform slipping, but paroxysmally, a little at a time. Every such readjustment of the walls of a fissure, whether by increasing lateral pressure (reverse faults) or by gravity (normal faults), gives rise to an earthquake. Earthquakes, therefore, although not confined to, are most common in mountain regions, especially if the mountains are still growing.

Thus, leaving out the monoclinal type, which seems to belong to a different category, all the phenomena, major and minor, of structure and of occurrences connected with mountains, are well explained by the theory of *lateral pressure* acting on lines of thick sediments accumulated on marginal sea bottoms, and softened by invasion of interior heat. This view is therefore satisfactory as far as it goes, and brings order out of the chaos of mountain phenomena. It has successfully directed geological investigation in the past and will continue to do so in the future.

But there still remains the question, "*What is the cause of the lateral pressure?*" The answer to this question constitutes the *physical theory.*

Thus far I suppose there is little difference of opinion. I have only tried to put in clear, condensed form what most geologists hold. But henceforward there are the most widely diverse views and even the wildest speculations. But let us not imagine, on that account, that we have made no progress in the science of mountain origin. The formal theory already given is really for the geologist by far the most important part of the theory of mountain origin. For I insist that for the geologist, *formal* theories are usually more important than *physical* theories of geological phenomena. That slaty cleavage is the result of a mashing of strata by a force at right angles to the cleavage planes, is of capital importance to the geologist, for it is a guide to all the investigations. To what property of matter this structure is due is of less importance to him, though of prime importance to the physicist. That the phenomena of the drift is due to former existence of a moving ice sheet is the one thing most important to the geologist, guiding all his investigations. Whether this ice sheet was caused by geographical or astronomical changes is a questton of wider but of less direct interest to him. So in the case of mountain ranges, the most important part of the theory is their origin by *lateral pressure* under the conditions given above. The cause of lateral pressure, though still of extreme interest, is certainly of less immediate importance in guiding investigations.

PHYSICAL THEORIES.

The most obvious view of the cause of lateral pressure refers it to the *interior contraction of the earth.* This may be called the

CONTRACTIONAL THEORY.

This theory is so well known that I will give it only in very brief outline. It assumes that the earth was once an incandescent liquid and has cooled and solidified to its present condition. At first it cooled most rapidly at the surface, and must have fissured by tension. But there would inevitably come a time when the surface, being substantially cool, and moreover receiving heat also from the sun, its temperature would be fixed, or nearly so, while the incandescent interior would be still cooling and contracting. Such has probably been the case ever since the commencement of the *recorded* history of the earth. The hot interior now cooling and contracting more rapidly than the cool crust, the latter following down the ever-shrinking nucleus would be thrust upon itself by lateral pressure with a force which is simply irresistible. If the crust were ten times, yea one hundred times more rigid than it is, it must yield. It does yield along the lines of greatest weakness, *i. e.*, along marginal sea bottoms, as already explained. As a first attempt at a physical theory it seems reasonable, and

therefore until recently has been generally accepted.

OBJECTIONS TO THE CONTRACTIONAL THEORY.

It is well known that American geologists have taken a very prominent part in the study of mountain structure and mountain origin. So much so indeed that the lateral pressure theory in the form given above, and the interior contraction as its cause, have sometimes been called the "American theory." It is also well known that my name, among others, especially Dana's, has been associated with this view. All I claim is to have put the whole subject, especially the formal theory, in a clearer light and more consistent form.* The formal theory I regard as a permanent acquisition. The contractional theory may not be so. It is natural, from my long association with it, that I should be reluctant to give it up. But I am sure that I am willing to do so, if a better can be offered. We all dearly love our own intellectual children, especially if born of much labor and thought; but I am sure that I am willing, like Jephtha of old, to sacrifice, if need be, this my fairest daughter on the sacred altar of Truth. Objections have recently come thick and fast from many directions. Some of these I believe can be removed; but others perhaps cannot in the present condition of science, and may, indeed, eventually prove fatal. Time alone can show. I state briefly some of these objections.

1. Mathematical physicists assure us that on any reasonable premises of initial temperature and rate of cooling of the earth, the amount of lateral thrust produced by interior contraction would be wholly insufficient to account for the enormous foldings.† Let us admit—surely a large admission—that this is so. But this conclusion rests on the supposition that the whole cause of interior contraction is *cooling*. There may be other causes of contraction. If cooling be insufficient, our first duty is to look for other causes. Osmund Fisher has thrown out the suggestion (a suggestion, by the way, highly commended by Herschel) that the enormous quantity of water vapor ejected by volcanoes, and the probable cause of eruptions, is not meteoric in origin, as generally supposed, but is original and constituent water occluded in the interior magma.‡ Tschermak has connected this escape of constituent water from the earth with the gaseous explosions of the sun.§ Is it not barely possible that we have in this an additional cause of contraction, more powerfully operative in early times but still continuing? See the large quantity of water occluded in fused lavas to be "*spit out*" in an act of solidification? But much still remains in volcanic glass, which, by refusion, intumesces into lightest froth. Here, then, is a second probable cause of contraction. If these two be still insufficient, we must look still for other causes before rejecting the theory.

2. Again, Dutton‖ has shown that in a *rigid earth* it is impossible that the effects of interior contraction should be concentrated along certain lines so as to form mountain ranges, because this would require a shearing of the crust on the interior. The yielding would be evenly distributed everywhere, and therefore imperceptible anywhere. This is probably true, and, therefore, a valid objection in the case of an *earth equally rigid in every part*. But if there be a subcrust layer of liquid, or semi-liquid or viscous, or even more movable or more unstable matter, either universal or over large areas, as there are many reasons to think, then the objection falls to the ground. For, in that case, there would be no reason why the effects of general contraction should not be concentrated on weakest lines, as we have supposed.

3. But again, it has been objected that the lines of yielding to interior contraction ought not to run in definite directions for *long distances*, but irregularly in *all* directions. I believe we may find the answer to this objection in the principle of flow of solids under very slow, heavy pressure. The flow of the solid earth, under pressure in *many* directions, might well be conceived as being deflected to the direction of least resistance, *i. e.*, of easiest yielding.

4. But again, it will be objected that the amount of circumferential shortening necessary to produce the foldings of some mountains is simply incredible; for it would disarrange the stability of the rotation of the earth itself. According to Claypole, in the formation of the Appalachian range, the circumference of the earth was shortened 88 miles, and in the formation of the Alps, 72 miles. Now this would make a decrease of diameter of the earth of 28 miles in the one case and 23 in the other. This would undoubtedly seriously quicken the rotation and shorten the day. This seems indeed startling at first. But when we remember that the tidal drag is all the time retarding the rotation and lengthening the day, and much more at one time than now, we should not shrink from acceptance of a counteracting cause hastening the rotation and shortening the day, and thus giving stability instead of destroying it. We must not imagine that there would be anything catastrophic in this readjustment of rotation. Mountains are not formed in a day nor in a thousand years. It requires hundreds of thousands or even millions of years—if physicists allow us so much.

The objections thus far brought forward, though serious, are by no means unanswerable. But there is one brought forward very recently which we are not yet fully prepared to answer, and may possibly prove fatal. I refer of course to the

5. *Level of No Strain.*—Until recently the interior contraction of the earth was considered only roughly and without analysis. It was seen that the surface was already cool and its temperature fixed, while the interior was still hot and cooling; and, therefore, that the exterior must be thrust upon itself and be crushed. But the phenomena are really far more complex than at first appears. It is necessary to distinguish between two kinds of contraction to which the interior layers are subjected, viz., radial and circumferential. If there were radial contraction only, then undoubtedly every concentric shell as it descended into smaller space would be crushed together laterally. But there is for all layers, except the surface, also a circumferential contraction, and this would have just the opposite effect, *i. e.*, would tend to stretch instead of crush. Therefore, wherever the decrease of space by descent is greater than the circumferential contraction, there will be crush, and where the circumferential contraction is greater than the decrease of space by descent, there will be tension and tendency to crack. There would be no *real* cracking, only because incipient cracks would be mashed out or rather prevented by superincumbent pressure. Where these two are equal to one another, there will be no strain of any kind. There is a certain depth at which this is the case. It is called the "level of no strain." To Mellard Reade is due the credit of first calling attention to this important principle.

Let us analyze the principle more closely. It is admitted that at the surface there is no contraction of any kind. It is also calculated that contractions of all kinds cease at a depth of 400 miles. It is believed, furthermore, that, commencing 400 miles below the surface and coming upward, the contraction increases very slowly from zero to a maximum at the depth of 70 miles, and then decreases again more rapidly to zero at the surface. This is shown in diagram, Fig. 1. In

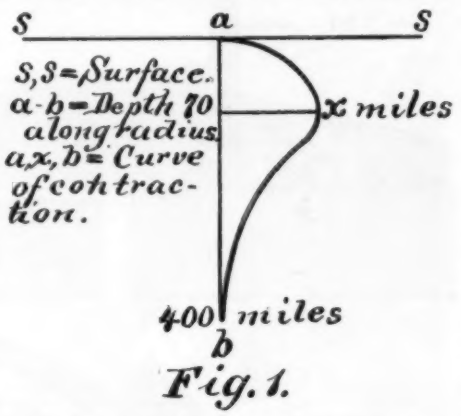


Fig. 1.

this figure the curves represent the relative rate of contraction, whether radial or circumferential, of the several layers. We use it, however, only to represent the latter. For, in considering the radial contraction, it is not the relative rate of the several layers that immediately concerns us, but their rate of *radial descent*. Now this is a *summation series*, and therefore increases to the very surface, but at different rates of increase. The law of increase of radial descent as we come toward the surface is shown in diagram, Fig. 2,* in which

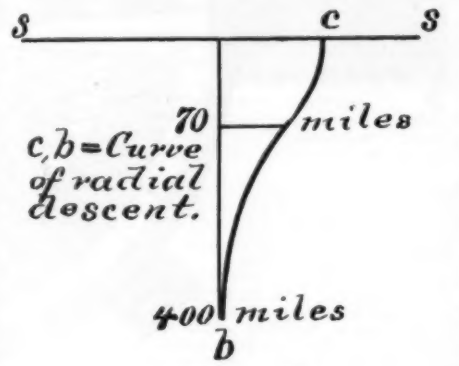


Fig. 2.

the rate of increase is greatest at 70 miles, just where the curve changes from concavity to convexity. If now we superpose these two diagrams, the depth at which the two curves, viz., that of circumferential contraction and that of radial descent, intersect is the level of no strain.

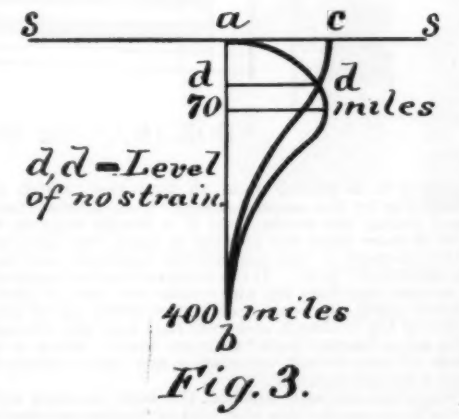


Fig. 3.

Now laborious calculations have been made by Davison, Darwin and Fisher to determine the depth of this level of no strain. All make it very superficial. Davison, taking an initial temperature of 7,000° F., makes it 5 miles below the surface. Fisher on the same data only 2 miles, and with an initial temperature of 4,000° only 0·7 of a mile. It is easy to see that if this be true, the amount of lateral thrust must be small indeed.

Now undoubtedly there is a true principle here which must not hereafter be neglected, but it is almost needless to say that these quantitative results are in the last degree uncertain. The calculations are of course based on certain premises. These are a uniform initial temperature of say 7,000° F., a time of cooling say 100 or 200 millions of years, and a certain rate of cooling under assumed conditions. The depth of the level of no strain increases with the time and is still going downward. In a word, in a question so complex both mathematically and physically, and in which the data are so very uncertain, every cautious geologist, while freely admitting the soundness of the principle, will withhold assent to the conclusions. Huxley has reminded us that the mathematical mill, though a very good mill, cannot make wholesome flour without good wheat. It grinds indifferently whatever is fed to it. It has been known to grind peas cods ere now. It may be doing so again in this case. Let us wait.

But, besides withholding assent and waiting for more light, I may add that these calculations, of course, go on the supposition that the whole contraction of the earth is due to loss of heat; but as we have already said, it may be due also to loss of constituent water. This would put an entirely different aspect on the subject.

ALTERNATIVE PHYSICAL THEORIES.

I have given the objections to the contractional theory frankly and I think fairly. They are undoubtedly serious. Let us see what has been offered in its place.

I. READE'S EXPANSION THEORY.

This, the most prominent among alternative theories, was first brought forward in Mr. Reade's book on "Origin of Mountain Ranges." Although I have carefully read all that Mr. Reade has written on this subject, I find it difficult to get a clear idea of his views. But as I understand it, it is in outline as follows: 1. Accumulation of sediments offshore and isostatic subsidence of the same. 2. Rise of isogeotherms and heating of the whole mass of sediments and of the underlying crust in proportion to the thickness of the sediments. 3. *Expansion* of the whole mass in proportion to the rise of temperature. If there were no resistance, this expansion would be in all directions (cubic expansion). 4. But since the containing earth will not yield to expansion laterally, this lateral expansion is satisfied by *folding*, and this in turn produces *vertical upswelling*. Thus the whole *cubic expansion is converted into vertical expansion*, which is therefore three times as great as the lineal expansion in any one direction. 5. Elevation would of course anyhow be greatest along the line of thickest sediment; but this by itself would not be sufficient to produce a mountain. 6. But, farther—and here the theory is more obscure—there is a concentration of the effects of expansion, along a comparatively narrow line of thickest sediments, by a *flow* of the hydrothermally plastic or even liquid mass beneath, *toward* this central line and then *upward* through the parted strata, folding these back on either side and appearing at the crest as the granitic or metamorphic axis. 7. In his latest utterances he seems to adopt the view of Reyer, viz., that the uplifted strata slide back down the slope, producing the enormous crumpling so often found, and exposing a wider area of granite axis. 8. From the same liquid mass which lifts the mountain come also the great fissure eruptions and the volcanoes.

Mr. Reade makes many experiments to determine the linear expansion of rocks, and he thinks that these experiments show that when cubic expansion is converted into vertical expansion, and this again concentrated along a line of one-fourth to one-fifth the whole breadth of the expanding mass, it would explain the elevation of the highest mountains. But still he seems uncertain if it be enough; in fact, he declares that if it were not for another factor yet unmentioned, he probably would never have brought forward the theory at all.

9. This factor is *recurrency of the cause and accumulation of the effects*. And here the previous obscurity becomes intensified. I have read and reread this part without being able wholly to understand him. He seems to think that when expansion had produced elevation, the mountain thus formed would not come down again by cooling and contraction: but on the contrary, would *wedge up by normal faulting and set in its elevated position*. Afterward, by new accumulation of heat, another elevation and setting would take place and the mountain grow higher, and so indefinitely or until the store of heat is exhausted. Therefore, he characterizes his theory as that of "*Alternate expansion and contraction*," or again as that of "*Cumulative recurrent expansion*." Such is a very brief, perhaps imperfect, but I hope fair outline of Reade's theory. It seems to me that there are fatal objections to it. These I now state.

Objections.—1. The first is *inadequacy* to account for the enormous foldings of mountains, especially when there is no granite axis to fold back the strata. It is true that Mr. Reade makes comparison between his own and the contractional theory in this regard, and seems to show the much greater effectiveness of his own. This may be true, if we accept his premises and compare *equal areas* in the two cases. But the contractional theory *draws from the whole circumference* of the earth and *accumulates* the effects on one line, while in Reade's theory the expansion is of course very *local*.

2. But the fatal objection is that brought forward by Davison. It is this: Sedimentation cannot of course increase the sum of heat in the earth. Therefore the increased heat of the sediments by rise of isogeotherms *must be taken from somewhere else*. Is it taken from below? Then the radius below must contract as much as the sediments expand, and therefore there will be no elevation. Is it taken from the containing sides? Then the sides must lose as much as the sediments gain, and therefore must contract and make room for the lateral expansion, and therefore there would be no folding and no elevation. I do not see any escape from this objection.

* "Theory of the Formation of the Great Features of the Earth's Surface," *Am. Journal*, vol. iv., pp. 345 and 460, 1872; and also "Structure and Origin of Mountains," vol. xvi., p. 95, 1878.

† *Cam. Phil. Trans.*, vol. xii., part ii., Dec., 1873.

‡ *Cambridge Phil. Trans.*, vol. xii., part ii., Feb., 1875. "Physics of the Earth's Crust," p. 87.

§ *Geol. Mag.*, vol. iv., p. 560, 1877.

‖ *Am. Jour.*, vol. viii., p. 13, 1874. *Penn. Monthly*, May, 1876.

* I have taken these figures from Claypole, but modified this one so as to make it a truer representation of the law.

Thus it seems that Reade's theory cannot be accepted as a substitute. Is there any other?

II. DUTTON'S ISOSTATIC THEORY.*

Dutton's discussion of isostasy is admirable, but his application of it to the origin of mountains is weak. The outline is as follows:

Suppose a bold coast line, powerful erosion and abundant sedimentation. The coast rises by unloading and the marginal sea bottom sinks by loading. Now if isostasy is perfect, there will be no tendency to mountain formation. But suppose a piling up of sediments—but on account of earth rigidity—without immediate compensatory sinking, and a cutting down of coast land without compensatory rising. *Then there would be an isostatic slope toward the land.* And the accumulated and isostatic sediments would slide landward, crumpling the strata and swelling them up into a mountain range.

The fatal objection to this view is that complete isostasy is necessary to renew the conditions of continued sedimentation and therefore to make thick sediments, otherwise the sediments quickly rise to sea level and stop the process of sedimentation at that place. But it is precisely a want of complete isostasy which is necessary to make an isostatic slope landward. Dutton refers to Herschel as having suggested a similar cause of strata crumpling and slaty cleavage; but the principles involved in the two cases are almost exactly opposite. Herschel supposes sediments to slide down steep *natural* slopes of sea bottoms and therefore *seaward*. Dutton supposed sediments to slide up natural, though down isostatic slopes, landward. Herschel's is a theory of strata crumpling and slaty cleavage, Dutton's a theory of mountain formation.

There has been no attempt to carry this idea of Dutton's to quantitative detail. It was probably thrown out as a suggestion in mere despair of any other explanation, for he had already repudiated the contractional theory. But the least reflection is sufficient to convince that such slight want of complete isostatic equilibrium as may sometimes occur would be utterly inadequate to produce such effects.

III. REYER'S GLIDING THEORY.‡

Prof. Reyer has recently put forward certain views fortified by abundant experiments on plastic materials. His idea in brief seems to be this: Strata are lifted and finally broken through by uprising fused or semi-fused matters, and these appear above as the granitic axis. As the axis rises, the strata are carried upward on its shoulders, until when the slope is sufficiently steep the strata slide downward, crumpling themselves into complex folds and exposing the granitic axis in width proportioned to the amount of sliding.

No doubt there is much value in these experiments of Reyer, and possibly such gliding does indeed sometimes take place in mountain strata, and some foldings may be thus accounted for. But the great objections to this view are, (1) that there is no adequate cause given for the granitic uplift, and (2) that it utterly fails to account for the complex foldings of such mountains as the Appalachian and Coast Range, where there is no granite axis at all. Reade, indeed, holds that the Piedmont region is the granite axis of the Appalachian, and that the original strata of the eastern slope are now buried beneath the sea. But American geologists are unanimous in the belief that the shore line of the great interior Palæozoic sea was but a little east of the Appalachian crest and the sea washed against land of Archæan rocks extending eastward from that line.

CONCLUSION.

After this rapid discussion of alternative theories in which we have found them all untenable, we return again to the contractional theory, not indeed with our old confidence, but with the conviction that it is even yet the best working hypothesis we have.

PARSEE FUNERAL AND TOWERS OF SILENCE.

To the Editor of the Scientific American:

I have got by me a large heap of old files of the SCIENTIFIC AMERICAN and its SUPPLEMENT. While going over the SCIENTIFIC AMERICANS I caught sight of an article headed "The Towers of Silence," of May 15, 1886, written by Colonel Floyd Jones. In some part of the article I find that the Colonel is misinformed regarding the dead ceremony of the Parsees. I, as a Parsee, can better let others know the true state of affairs, and would try to give a fuller description of the dead ceremony.

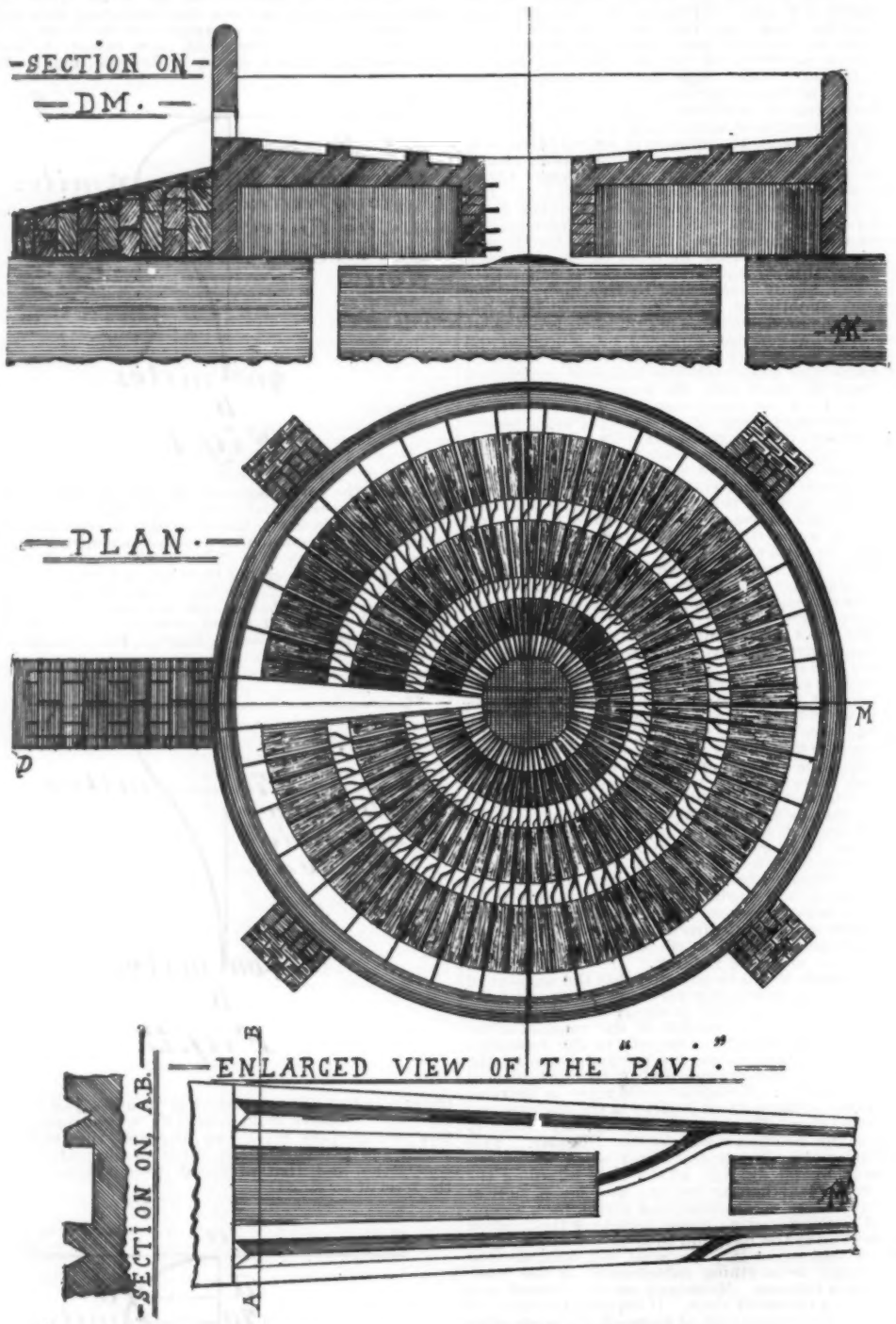
To describe the ceremony relating to the death of a Parsee: When the case is seen to be hopeless, the body of the dying man is washed and dressed in clean but old white clothes. The "Dustoor," or "Mobed," with other priests, repeat sundry texts of the "Zend Avesta," the substance of which tends to afford consolation to the dying man, and he breathes a prayer on his behalf for the forgiveness of his sins: "May the merciful Lord give you a good and happy abode in the world to which you are about to enter, and may He have mercy on you." If the dying man be in the possession of his senses, he himself joins in these exercises; if not, his son, or nearest relative, or the family priest, bends over him, repeating the words in his ears. When life becomes extinct, the body is wrapped in clean clothes and placed on an oblong piece of polished stone, which is laid on the floor. The hands are laid crosswise and joined upon the chest, and the feet are crossed and tied or are kept straight. There is one point in connection with the ceremonies performed over a dead body, about which people of other religious persuasions entertain most incorrect ideas. The face of the deceased Zoroastrian is exposed to the gaze of a dog three or four times during the recitation of the funeral sermon or oration. This seems to have led to the erroneous supposition that before the dead body is removed from the house, a dog is made to lick it or eat some portion of its flesh. It is scarcely necessary to say that this belief has no foundation whatever. This ceremony is called "Sagdid." I may here mention that they ascribe to the glance of a dog the power of scaring away the evil being. With the same view, evidently, a dog is conducted over the way by which a deceased person has been carried, in order to make it again accessible for man and beast. The dog to be employed for "Sagdid" must have certain special marks; he must be four-eyed, must have two black spots over his eyes, and must also be of a yellow color or white with yellow ears, so that the ceremony might be efficacious. This belief, however, is not generally shared in by the educated Parsees of the present day. The female members and relatives of the family then sit down together on a carpet spread in the room in which the body is placed, the men sitting on chairs or benches in the veranda. If death takes place at night, the body is kept in the house till the next morning; but if during the day—four or five hours before sunset—it is removed to its final resting place in the afternoon. Until the last funeral ceremony has been performed, a priest continues saying certain prayers before the corpse, burning sandalwood over a fire all the time.

When the time for the removal of the body approaches, it is placed upon an iron bier, which is brought in by the corpse bearers. Two priests then stand facing the corpse, but if a female bearing a child of more than five months is dead, two pairs of priests instead of one perform the ceremony, and recite the seven "Has." If the deceased be the husband of a surviving wife, his wife breaks the pair of glass anklets which she wears and throws them on to the corpse of her husband, and from that time she always puts on a black "Sadi" without border, which is a mark of widowhood, ornaments not being resumed until a second marriage.

When the recital is finished, the body is taken out of the house on the iron bier, and carried on the shoulders of four "nasesalars," or corpse bearers, to the "Dokhma," or the Tower of Silence, which is generally erected in a solitary place and upon an eminence. The relatives of the departed one naturally give way to cries and lamentations. The male relatives and friends of the deceased follow the dead body in funeral procession on foot. The carriers of the bier have their hands, feet and head bound in white cloth. Two sets generally accompany, so as to permit a change at intervals on the road to the "Dokhma," or Tower of Silence. The followers of the funeral procession proceed in couples, holding a handkerchief between them, and are in full dress, that is to say, the jama is worn. After the dead body is removed from the house, cow's urine is thrown as a disinfectant on the spot where it had lain, as well as on the path by which the corpse was taken out.

Arriving at its resting place, the iron bier is put upon the ground, and the face of the deceased uncovered for a few minutes, in order that a last look may be taken of it, and the whole assembly bow before it. Here the dog is again brought in and made to gaze at the corpse. After a few minutes the body is taken by the bearers inside the "Dokhma," and the vultures, which are always in the immediate vicinity, soon denude it of flesh.

The so-called Towers of Silence, which serve the Parsees in Bombay as places for the disposal of their dead, crown the summit of the magnificent Malabar Hill, which rises above the city. The view which they



"DOKHMA," OR TOWER OF SILENCE.

present is naturally most gloomy. A body of lazy vultures, densely crowded, guard the edge of the tower. There they sit, immovable and motionless, save when a funeral procession approaches, and the flock are filled with excitement. They fly upward with screams, and as soon as the dead body is laid within the tower by the bearers, they throw themselves with greedy haste upon their prey. In a few minutes the dreadful work is finished, and the heaven-sent birds return satiated to their place to wait for fresh food.

When the corpse bearers take the body in the "Dokhma," they tear the clothes from the deceased and expose him or her to be devoured by the vultures. The clothes are taken out of the tower by the corpse bearers and deposited in a separate compartment set aside for them in the tower compound. Here the bearers take a bath and return home. The priests, relatives and friends who have attended the funeral, wash their faces and hands and offer a prayer to the Almighty; and it is at this time that they loosen the handkerchief which they kept between each pair. After this every one goes to his own place. This is for

* Phil. Soc. of Washington Bull., vol. xi., pp. 51-64, 1889.

† *Phil. Mag.*, vol. xii., 197, 1856.

‡ *Nature*, vol. xlvi., p. 224, 1892, and vol., p. 81, 1892.

those who follow the procession; but those who do not follow, sit in the house of the deceased for about fifteen or twenty minutes after the corpse has been carried away from the house, and then they, too, retire to their own places.

On the death of any person, his friends, neighbors and acquaintances visit the relatives of the deceased every morning and evening for three days consecutively to offer consolation to them, and sit in long array for a few minutes on benches and chairs placed along the side of the house.

Originally the "Dokhmas" were certainly nothing more than natural hills or primitive elevations of sand, earth or stones. In course of time the structure became a more elaborate one. The "Dokhmas" must be erected on places situated on high, on the tops of hills or slopes. It is a rule that they must be uncovered and exposed to the solar rays and rain. The best idea that I can give of its outward appearance is to refer to the large circular gasometers attached to gasworks, the only difference being that the "Dokhmas" are open at the top, while their circular walls are built of the hardest stone, faced with white "Chunam" or lime plaster. The walls are from 20 to 30 feet in height, and the diameter of the largest "Dokhma" in Bombay is 90 feet. Inside the tower is a circular platform entirely paved with large stone slabs, and divided into three rows of exposed receptacles called "Pavis" for the bodies of the dead. As there are the same number of "Pavis" in each concentric row, they diminish in size from the outer to the inner ring, and that by the side of the wall is used for the bodies of the males, the next for those of females, and the third for those of children. These receptacles or "Pavis" are separated from each other by ridges called "Dandas," which are about an inch in height above the level of the "Pavis," and channels are cut into the "Pavis" for the purpose of conveying all the liquid matter flowing from the corpses and rainwater into a "Bhandar" or a deep hollow in the form of a pit, the bottom of which is paved with stone slabs. This pit forms the center of the tower. When the corpse has been completely stripped of its flesh by the vultures, which is generally accomplished within an hour at the outside, and when the bones of the denuded skeleton are perfectly dried up by the powerful heat of the tropical sun, and other atmospheric influences, they are thrown into this pit, where they crumble into dust—the rich and the poor, the young and the old—thus meeting together after death in one common level of equality. Four drains are connected leading from the body of the pit. They commence from the surrounding wall of the "Bhandar" and pass beyond the outside of the tower into four wells sunk in the ground at equal distances. At the mouth of each drain, charcoal and sandstone are placed for purifying the fluid before it enters the ground, thus observing one of the tenets of the Zoroastrian religion, that "the mother earth shall not be defiled." The wells have a permeable bottom, which is covered with sand to a height of 5 or 7 feet. These "Dokhmas" or towers of silence are built upon one plan, as shown in the illustration, but their size varies. Some of the leading dimensions of the "Dokhmas" shown are as follows:

	Feet.
Interior diameter of the tower, as limited by the parapet	62
The outmost diameter	70
The outer diameter at the plinth at the surface of the ground	66·8

The frustum or plinth has a batter of 1 foot in 8 feet.

MANECK K. THANEWALA.

Rutlam, Central India, July 19, 1893.

MARRIAGE IN BURMA.

A CHAPTER in the Burma census report, dealing with what is called the "civil condition" of the people, gives much interesting information regarding marriage in that country. From the tables, marriage appears to be much less common than in India, but this is said to be due to the fact that there is no child marriage among the Buddhists and Nat worshipers, who form the bulk of the population. Moreover, in Burma marriage is generally the result of mutual affection between the parties after they have reached years of discretion. On the other hand, marriage is more common there than in European countries, for the tie is more easily formed and more easily dissolved, while motives of prudence have not the same weight. Destitution is almost unknown, and the wants of life in the temperate climate of Burma are more easily satisfied than in the colder countries of Northern Europe.

A young Burmese couple can start life with a *da* and a cooking pot. The universal bamboo supplies materials for building the house, lighting the fire, carrying the water from the well, and may even help to compose the dinner itself. The wife is usually prepared to take a share in supporting the household, and thus she has gradually acquired a position of independence not always enjoyed by married women elsewhere.

It has been decided that, under the ancient Buddhist custom prevailing in Burma, a husband cannot alienate property jointly acquired after marriage without the consent of his wife. Few marriages take place where either party is under fifteen, and the usual age is between fifteen and twenty-five.

Polygamy now practically no longer exists, although in ancient times the Burmese were polygamists as well as slaveholders. "Most Burmese have only one wife, and few more than two. The first, or head wife, is usually the choice of the husband in his youth, and when she ceases to have children she often assists in the choice of a young wife, who is bound to obey her."

The ease with which divorce is obtained is said to be one of the causes why polygamy is so rare. The terms of divorce are based on ancient rules, one of which is that the party wishing the separation can take his or her property and no more; the other party takes all the rest, including the children. The safeguard against caprice in husbands is not merely public opinion, which condemns too frequent divorces, but the self-respect of women, which prevents them from marrying a man who has divorced his wives too freely. The privilege of perfect freedom in this respect is said to be rarely abused. "Divorce is very rare, a fact attributable equally, perhaps, to the high position occupied by women in Burmese society, the care with which marriage contracts are entered into and the extreme evenness of temper which characterizes both sexes."

A LUMINOUS CEPHALOPOD.

SINCE the microtome has replaced the green box of our fathers and the lens has paled before the microscope, it may readily be imagined that works on natural history are becoming obscure sanctuaries, in which the eye of the profane, but slightly habituated to the mysteries of the cell and the beauties of karyokynesis, can no longer meet with facts that are interesting and worthy of captivating the intelligence. Let those sorrowing minds that have such thoughts be reassured. Amid the researches which, it must be admitted, are often very dry, the disciples of the scalpel often bring to light curious facts that are comprehensible to every one, and that the simple observation of last year

FIG. 1.—A LUMINOUS CEPHALOPOD. (*Histiotheutis Ruppellii.*)

would have been incapable of showing. We desire to take here, for an example, only a work recently published by Prof. Joubin, of the Faculty of Sciences of Rennes, and which we shall briefly analyze.

The cephalopods are, as well known, marine mollusks, whose head, very distinct from the rest of the body, is provided with two large eyes and a circle of arms surrounding the mouth, and more or less consolidated at the base, and provided with a large number of suckers upon their internal surface. It is to this class that belong the poulps, the argonauts, the octopuses, etc., which are known to every one.

Among the little known and rare genera of the cephalopods of our coasts must be particularly mentioned that of *Histiotheutis*, with which we are going to occupy ourselves.

Verany, in his magnificent work on the cephalopods of the Mediterranean, describes several species of *Histiotheutis*, and is not sparing of eulogiums upon certain abundant spots that cover their skin and emit a phosphorescent light. "I was called," says he, "by a fisherman, who showed me a *H. Bonelliana* clinging to his net. I had it captured and put into a bucket of water. It was at this moment that I enjoyed the astonishing spectacle of the brilliant points that decorate the skin of this cephalopod, which is otherwise so extraordinary by its form. Now it was the luster of the sapphire that dazzled me, now it was the opaline of the topaz that rendered it more remarkable, and again these two rich colors confounded their magnificent rays. During the night the opaline points projected a phosphorescent luster, and this makes of this mollusk one of the most brilliant productions of nature."

As a description this is very pretty, but it must be confessed that after reading it we have not learned much of anything. We know of one more luminous animal, and that is all. Let us now see our animal in the grasp of histology.

The *Histiotheutis Ruppellii*, studied by Mr. Joubin, was taken at Nice at a depth of 800 meters in the sea. Its total length was nearly one meter. The animal was dead, and had lost its phosphorescence.

The spots, now large, now small, according to the region, are very regularly oval, and elongated in the direction of the length of the body. One of the extremities, always the lower, of each spot carries a small, nearly spherical black mass deeply embedded in the skin. Verany describes this mass as a very brilliant point. The rest of the spot, according to his observations, was bluish and slightly iridescent. It will be remarked, besides, that the brilliant point is situated sensibly in the focus of the elliptical spot, which, on another hand, is not plane, but slightly concave. (Fig. 2, No. 1.)

Let us now make some histological sections and study more closely the structure of the *mirror* and the apparatus that produces light.

The mirror is formed of plates that are superposed and very intimately conjoined. The lowest layer consists of a very compact mass of those pigmented cells called chromatophores. It is a true black screen.

The photogenic organ is more complicated. Its form and position are well shown in the longitudinal section given in Fig. 2 (No. 3). It comprises, in the first place, at the periphery, a very dense black layer, analogous to that of the mirror. It is covered internally by a thick layer of extremely curious cells (Fig. 2, No. 2).

The cells, which have a central nucleus, are absolutely transparent, and each resembles a small crystalline lens. Of oval form and inflated toward the center, they have sensibly the aspect of two watch glasses applied one against the other.

In the section they are seen to be formed of a very large number of concentric lamellæ set into each other and not continuing from one face to the other; in fact, a non-fibrous plane traverses the cell and divides it exactly into two equal parts. In order to obtain a clear idea of the structure of these cells, it is necessary to imagine a series of smaller and smaller watch glasses set into each other accurately. A second series similar to the first is applied to the latter in such a way that the concavities of the two series free each other and that the center is occupied by nuclei of different densities. Finally, they are all directed in such a way that their longitudinal axis is parallel with the surface of the black screen.

Further within comes the photogenic layer, upon the complicated structure of which we shall not dwell.

Finally the apparatus terminates in a series of transparent media composed within and without of (1) a crystalline cone, (2) a convexo-convex lens, and (3) a concavo-convex lens.

What must be thought, now, of the operation of this singular apparatus? In the first place, it is evident, from the observations of Verany, that this is what produces the phosphorescence of the *Histiotheutis*. Through the microscope, we can, in addition, localize the production of the light in the photogenic layer mentioned above. The luminous rays are reflected upon the black screen and the layer of crystalline cells. A portion of the light thus makes its exit directly from the apparatus, while the other portion is concentrated by the crystalline cone and the two lenses upon the concave mirror, which afterward reflects it to the exterior, after making it undergo a series of successive refractions, somewhat as in the jet of the Colladon fountain. Upon the whole, these curious points that cover the body of our cephalopod are fully comparable to Mr. Trouve's photophores, which we daily use for fine dissections, and to which would have been added reflecting mirrors covered with a series of transparent layers of unequal densities for the purpose of communicating iridescent tones to them.

Formerly we admired only the plays of light of the photogenic points. To-day, thanks to the progress of histology, we find in an animal such physical apparatus as a generator of light, a luminous condenser, a concave mirror and a luminous fountain. The more we fathom the mysteries of nature, the more we are led to admire them.—*La Nature.*

THROUGH THE YANGTSE GORGES.

A PAPER lately issued by the Chinese Imperial Maritime Customs contains a report of the journey in boats up the Yangtse to Chungking of the customs' staff

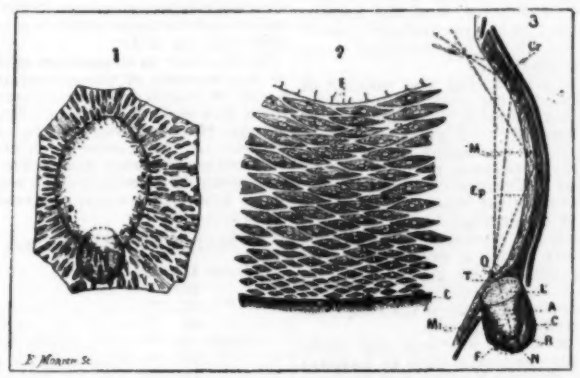


FIG 2.—ONE OF THE PHOSPHORESCENT SPOTS ISOLATED AND MAGNIFIED.

External view of one of the spots (×12). 2. Transverse section of the reflector. 3. Median transverse section of the phosphorescent apparatus as a whole (×16). Theoretic travel of the luminous rays concentrated at the point, O. Cr, chromatophores; C, black screen; R, reflector; Ep, epidermis; L, convexo-convex lens; A, transparent cone; N, nerves; F, photogenic layer; M, upper mirror; Mi, lower mirror; T, concavo-convex lens.

sent to that port to open it to foreign trade. The time taken from Ichang was 33 days, and the labor of tracking the boats through the cataracts was very great. The Ichang gorge, which is the first, is described as presenting to view high and in places inaccessible mountains, beautiful glens and charming scenery in general, while the stream offers no great difficulties to

navigation. In the first 8 days the distance traversed was only 40 miles.

The most famous of the rapids in this part of the river, the Yeh-tan, is described as formed by a reef of rocks commencing on the left bank, near the mouth of a ravine, through which a mountain stream discharges. The reef runs diagonally across the river for about ⅔ of its width, leaving the remainder of the channel clear; but the current sweeps past the precipitous bank in a seething, swirling mass of water. It took the party from 1 P. M. to dusk before their boats were hauled up this rapid. Some of the gorges are described as exceedingly impressive, and even gloomy, in their character.

Wan-Usien, one of the chief cities on this part of the river, is said to look like a miniature Gibraltar. It is situated in a large bend of the river, the walled portion being small, while the western portion is of considerable extent and contains many handsome buildings. Fine temples, surrounded by trees, set off the whitewashed houses, which rise, tier above tier, from the water to the summit of the long ridge on which the city is built. At the back rises a mountain, the top of which is fringed with crags and crowned with what looks like a fort.

Mr. Hobson, the Commissioner of Customs and chief member of the party, says there can be no steam navigation of this part of the river until a detailed survey has been made; but a deep-water channel, free from rocks and with a strong current, exists the whole way, generally in mid-channel. There would be no difficulty about anchorages, for sheltered nooks and coves abound in which the largest junks moor in safety. The pilot of the party, who had been 40 years on the upper river, was of opinion that steamers of the same draught as the great Szechuan salt junks—viz., 5 ft.—could reach Chungking for 11 months in the year. The rapids vary considerably with the rise and fall of the river, many of them ceasing to exist with high water, while as the larger rocks become submerged new and more formidable ones come into existence.

Mr. Hobson says that the amount of land devoted to poppy culture, even along the river bank, is "something astounding, and it would almost appear that if the supply of Indian opium were cut short to-morrow Szechuan alone would be able to provide for the wants of smokers over a considerable portion of the empire."

He met no real specimen of the debauched opium smoker so constantly paraded for the sympathy of Europeans. The agricultural and boating population of Szechuan slave like beasts of burden, and their yellow and generally jaundiced complexions testify to their indulgence in the opium pipe, and yet nowhere in the world will a hardier, better tempered and more decent lot of people be found.

"Whether mild indulgence in opium does not tend to secure immunity from various types of malarial disorder, to which, owing to poor living and damp dwellings, they would otherwise be liable, is a nice point for the medical faculty to elucidate."

THE GEOGRAPHICAL POSITION AND HEIGHT OF MOUNT SAINT ELIAS.

By Dr. T. C. MENDENHALL.

IN connection with the survey of the boundary line between Alaska and the British Northwest Territory it became necessary to determine the geographical position of Mount Saint Elias.

Previous approximate determinations had shown that the peak of this mountain must be very near the 141st meridian, which constitutes the greater part of this boundary line, and that its distance from the seacoast must be very nearly ten marine leagues, which by treaty is to determine the position of the line in the absence of a range of mountains parallel to the windings of the coast.

It thus appeared that this peak is likely to prove of very great value as a corner stone in this great boundary line, being at the junction of the 141st meridian and that part of the line which is so vaguely defined in the treaty.

The execution of the work in the immediate vicinity of the mountain was intrusted to assistants J. E. McGrath and J. Henry Turner, whose previous explorations and long residence in the interior of Alaska in connection with the determination of the 141st meridian are well known to the members of this society.*

The complete reduction of the observations made has not yet been accomplished, but enough has been done to show the geographical position of the mountain peak within a very small error, and the society will probably be interested in the preliminary results of this work, which are not likely to be modified sensibly by the completed calculations.

The field work was executed during the summer of 1892. The party was carried to the working ground by the Coast Survey steamer Hassler, in command of Captain Harber, who personally took great interest in the work and facilitated its successful performance very much, taking a very important part, in fact, in the determination of the difference of longitude between Sitka and the astronomical station at Yakutat Bay. In the absence of telegraphic connection with any of these points, a series of chronometric journeys was made between Tacoma, which is near one of the telegraph longitude stations of the great system of the United States Coast and Geodetic Survey, and Sitka, which has been fixed as the base of the longitude work throughout the Territory of Alaska.

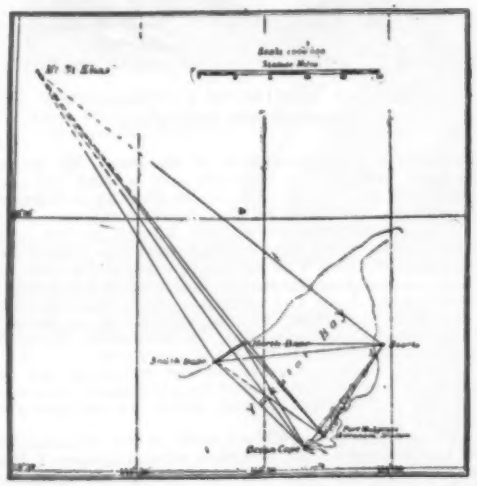
Contemporaneously a series of journeys was made between Sitka and the astronomical station at Yakutat Bay by the Coast Survey steamer Hassler, and by these two loops the longitude of the stations was connected with that of the telegraphic system of the United States. Time observations at Tacoma and the comparison of chronometers at that point were under the direction of assistant J. F. Pratt. Six complete chronometer tours from Tacoma to Sitka and return were made on board of the steamer Queen, the chronometers being in charge of Mr. T. D. Davidson, San Francisco; this link having also been taken in by the Hassler chronometers on her way to and from the field, seven complete journeys are available between Tacoma and Sitka. Six complete journeys between Sitka and the astronomical station at Yakutat Bay were made. An astronomical station was established at Sitka under the direction of sub-assistant Fremont Morse, who had charge of time observations and the comparison of both sets of chronometers on reaching that point. Seven chronometers made the journeys between Tacoma and Sitka, and the same number between Sitka and Yakutat Bay.

The astronomical station at the latter place was in charge of assistant J. Henry Turner. The connection of this station trigonometrically with the summit of Mount Saint Elias was under the direction of assistant J. E. McGrath. The astronomical station was on the southern side of Yakutat Bay, and the measured base line from which the triangulation was developed was on the northern side. The length of this line was a little less than 7,000 meters, or about four and a half miles. The scheme of triangulation is shown on the accompanying sketch. The latitude of the astronomical station was determined by vertical circle observations of the sun's limb by the method of circum-meridian altitudes and also by the use of a meridian telescope and the Talcott differential method. The vertical circle used was ten inches in diameter and read to five seconds by means of four verniers. The latitude here given depends on these observations, as those made by the meridian telescope have not yet been reduced.

Of the six chronometric tours between Sitka and Yakutat Bay, three only have been reduced, and the results are as follows:

First trip, June 8 to 13; difference of longitude	17 m.	48·17 sec.
Second trip, June 24 to 29; difference of longitude	17 "	48·31 "
Third trip, July 9 to 14; difference of longitude	17 "	48·16 "
Of which the indiscriminate mean is	17 "	48·21 "

A preliminary reduction of a portion of the chronometric comparisons between Tacoma and Sitka gives for the longitude of Sitka 9 h. 1′ 20·5″, from which we have the adopted longitude of Yakutat astronomical station 9 h. 19′ 8·7″. The latitude of this station from circum-meridian observations on the sun's limb, consisting of sixteen pointings on the sun near culmination on August 1, 1892, was 59° 33′ 51·8″, and on August 11, 1892, from twenty pointings, the result was 59° 33′ 48·2″, the mean of which is 59° 33′ 50″, which is accepted as the latitude of this station, subject, of course, to further small correction from the reduction of the results obtained from the meridian telescope work. Extending these co-ordinates to the summit of Mount Saint Elias by means of the scheme of triangulation as shown in the sketch, the latitude of the summit is found to be 60° 17′ 35″, and the longitude 140° 55′ 21·5″.



TRIANGULATION IN THE VICINITY OF MOUNT SAINT ELIAS.

The principal base for the determination of the position of the summit of the mountain was a line connecting Mount Hoorts and South Base. The length of this line was a little less than 38,000 meters, or about 23½ miles, and the angle which is subtended at Mount Saint Elias was about 20°.

Incidentally in connection with this work, the height of the summit of the mountain was determined. A series of zenith distance measurements was executed from five stations, namely: North Base, South Base, Mount Hoorts, Ocean Cape, and the astronomical station. At the latter point observations were made on fourteen different days. The result for each day is the mean of three sets of six repetitions each, and the series is as follows, the observations being made near noon:

ZENITH DISTANCE OF MOUNT SAINT ELIAS.

June	11, 1892	87° 20′ 50·3″
"	18, "	87° 20′ 64·3″
"	27, "	87° 20′ 51·8″
"	28, "	87° 20′ 51·3″
July	9, "	87° 20′ 57·1″
"	10, "	87° 20′ 49·8″
"	11, "	87° 20′ 44 8″
"	13, "	87° 20′ 40 6″
"	23, "	87° 20′ 59·8″
"	29, "	87° 20′ 36·1″
Aug.	1, "	87° 20′ 53·6″
"	11, "	87° 20′ 52·0″
"	17, "	87° 20′ 50·8″
"	18, "	87° 20′ 41·2″
	Mean of 14 days	87° 20′ 50·2″

It will be seen that in the total fourteen days of observation the range of variability in vertical angles amounted to but 28″, indicating remarkable steadiness in atmospheric conditions.

The observations for height at other stations, although less numerous, are extremely satisfactory. The great uniformity of the final results for the height of the mountain as computed from observations at the five different stations is exhibited in the following table. The remarkably close agreement of these figures is satisfactory evidence that this determination of the height of the mountain is such as to leave little to be desired.

SUMMARY OF HEIGHT AND POSITION.

Mount Saint Elias from:	
North Base	18,014 feet.
South Base	18,012 "
Mount Hoorts	18,017 "
Ocean Cape	18,012 "
Astronomical station	18,000 "
Height, adopted mean	18,010 "
Latitude	60° 17′ 35″
Longitude	140° 55′ 21·5″

It is interesting to note that in the light of the information of the last year or two, it can no longer be claimed that Mount Saint Elias is the highest peak upon the continent. This distinction seems to belong to Mount Orizaba, in Mexico, which has recently been measured by means of railroad levels and trigonometrically by Dr. J. T. Scoville, of Terre Haute, Indiana. The height of this mountain, as obtained by Dr. Scoville, is 18,314 feet. The character of the observations is such that it does not seem likely that this result will be found to be very many feet in error. It, therefore, appears to be entirely safe to say that Orizaba is the highest peak in North America, and that its altitude exceeds by two or three hundred feet that of Mount Saint Elias. A detailed report on the latter mountain, together with the results of revised and complete calculations, will be published in due time.—*Nat. Geog. Mag.*

SOME UNREALIZED ANNEXATION PROJECTS.

By W. A. CURTIS.

THEORETICALLY, the policy of the United States has always been opposed to the annexation of new territory; and yet this policy has been so frequently, so constantly violated, that practically the policy of the United States is distinctly favorable to annexation. While it is true that so far only contiguous territory has been annexed by us, it is true that more opportunities of annexation have been accepted than have been refused, and that, without exception, every movement for annexation has experienced strong opposition. When the country was only a narrow strip along the coast, the mass of the citizens then, as now, declared that annexation of new territory was contrary to the national policy, that it was unwise to possess territories lying at a distance from the centers of population, that the country was large enough. Except for the strenuous efforts of a few far-seeing statesmen, England would have held Wisconsin and Michigan after the revolution, Spain would have retained Florida, Southern Alabama, and Southern Mississippi, and France would have held the vast territory west of the Mississippi. Wisconsin and Michigan rightfully belonged to us, and were held by England in defiance of treaty; Florida, Alaska, and the French possessions were acquired by purchase but all our acquisitions of territory were not peaceably obtained.

Few historians mention the fact that after the cession of Louisiana, in 1803, there was a tract of some 900 square miles in Southern Mississippi which was retained by Spain. In the exchanges of Louisiana between Spain and France, this tract had been retained by Spain and had not passed to the United States in the final cession. A party of filibustering Franco-Americans, newly made citizens by the treaty, tore down the Spanish flag, expelled the Spanish soldiers, and declared the territory annexed to the United States. This forcible annexation was never made the subject of protest by Spain; and it is doubtful if the authorities at Washington were ever more than dimly aware that Spain had been possessed of this territory and had been evicted.

The annexation of Texas was practically a conquest, and the annexation of what has since become California, Arizona, and other States and Territories, was made by conquest, although the sum of $15,000,000 granted in compensation was much more than the territory was then worth to Mexico, or ever would have been worth if it had remained for Mexican capital and enterprise to develop it.

Besides the annexation projects which have succeeded, there have been many annexation projects that have failed—projects, too, that went beyond a mere agitation by a few newspapers and public men, and reached the stage of declaration of sovereignty, of petitions from the land desiring annexation. It is natural that the annexation of the contiguous territory of Canada, Mexico, and of Cuba should be occasionally agitated; but the first requisite of such annexation, the consent of those countries, has never yet been gained. There is, and has always has been, a strong annexation party in Canada, at times very strong. Angered over different grievances, Newfoundland, Nova Scotia, Manitoba, and Quebec have talked of annexation. The fisheries dispute with France in Newfoundland and the coal question in Nova Scotia have weakened the loyalty of these provinces. The hostile French and English parties in Manitoba and Quebec have each expected to gain the advantage of the other by annexation. Spain has more than once tentatively offered Cuba to the United States, the last time hinting at an exchange of the Queen of the Antilles for the sum of $300,000,000. Mexico semi-officially offered the northern State of Chihuahua for a like sum, a few years ago, the grazing and mining interests of that vast barren state being largely in the hands of non-resident Americans. Italy once offered to sell us a small Mediterranean island which should do double service as a watering place—coaling station it would be in these days of steam—and to bring the republic into the European question. But coaling stations were then in the future, and the Monroe doctrine was not to be abandoned for the questionable distinction of having a voice in European affairs.

The unrealized annexation projects which got beyond mere informal discussion by the people at large, which actually received the official attention of our own government, or the government of the country which it was proposed to annex, ought to be of interest at pres-

* An account of their work appears in "Nat. Geog. Mag.," vol. iv., 1892, pp. 177-197.

ent. Few histories make mention of them and information concerning them is hard to find.

The petition of annexation from Hawaii is not the first opportunity for acquiring possessions in Polynesia that has been presented to us. During Madison's administration, David Porter, "Essex" Porter, father of Admiral Porter, of the civil war, raised the American flag over the Marquesas Islands, even fortifying and garrisoning Nukahiva, the most important island of the northern group. The Marquesas Islands are a cluster of thirteen small islands in the South Pacific, lying about 700 miles south of the equator, having a population of 10,000 and an area equaling fifteen American townships. Although the southern group of the cluster was discovered and named in 1595, by a Spaniard, Mendana de Neyra, the other islands were not discovered until 1791, when Marchand and Ingraham, two Americans, discovered them, naming the two largest islands Washington and Franklin. By right of discovery, all but four of the islands belonged to the United States, and Spain had never claimed these four. Porter saw their value to our Pacific whaling fleet as a watering place and annexed them. Were the question of the annexation of those islands before us now, there is little doubt but that we would take them. They are very fertile, producing all the staples of the tropics, and are not cursed with an unhealthy climate, or venomous reptiles and insects, the usual drawbacks of tropical countries, and besides these recommendations, they would be of value as a naval station. But at the time of Porter's annexation we were embarrassed by the 1812 war, and Madison ordered the islands to be abandoned. In 1842 they were annexed to France by Admiral Du Petit-Thouars, and have remained in the undisputed possession of that power ever since.

In the year 1822 San Salvador, the smallest in area, but most thickly peopled and prosperous of the Central American republics, decreed itself annexed to the United States. With Mexico and the other Central American republics, San Salvador had become independent of Spain in 1821. In the unsettled condition of affairs following independence, Augustin Iturbide had made himself Emperor of Mexico, and sought to add Central America to his empire. To escape incorporation with Mexico, San Salvador decreed union with the United States, not taking the trouble to consult the latter country on the matter. Before action was taken by the United States, Iturbide was overthrown. Relieved from danger, San Salvador revoked the decree of annexation. It is hardly probable that the United States would have accepted San Salvador. We held no territory nearer than Oregon, and Great Britain claimed Oregon and seemed ready and able to enforce its claim. Considering the difficulty of communication of those days, San Salvador was as far from the United States as Central Africa is now.

One of the plans dear to the heart of General Grant was the annexation of St. Thomas and Santo Domingo. The former is a small West Indian island belonging to Denmark, valueless except as a coaling station. It has a barren soil and does not produce enough to feed its inhabitants. The treaty for its sale was drawn up, but the Senate refused to ratify it. Denmark was surprised and angered by the unexpected turn of affairs, and Grant was sorely disappointed. Five or six days south of New York lies Santo Domingo, an island as large as Ireland and occupied by the republics of Hayti and Dominica. The former republic occupies a third of the island and has a population of less than five or six hundred thousand—all negroes, except a few mulattoes. Dominica has a population of less than two hundred thousand, about one-tenth being pure white, the rest being a mixed race, in which the white blood largely predominates. Negotiations for the annexation of Dominica, or Santo Domingo, as it is called by us—the name of the whole island being improperly applied to it—began in 1869. Secretary Seward had visited the island some years before and broached annexation to the dictator-president, Buenaventura Baez. In July, 1869, General Babcock was sent as American agent to examine the condition and resources of the country. In November he leased Samana Bay, to be used as a coaling station. A vote was then taken by the Dominicans and resulted unanimously in favor of annexation. However, in view of the subsequently disclosed facts that the first man who cast a vote against annexation was promptly shot by the guard at the polls and that forty-five prominent citizens were banished for saying that they would oppose annexation, this apparent desire for annexation might not have been a heartfelt one at first. Nevertheless, before the negotiations were over, the American commissioners, in their travels from one end of the country to the other, found everybody anxious for annexation. Various commissions of scientists and statesmen were sent to investigate the climate and resources of the island. One expedition which, including the sailors of the ship carrying it, numbered 716 men, remained in the island a year and lost by death only one man, and he died from a disease contracted elsewhere. The reports of the various commissions agreed in saying that Dominica's climate was as healthful as that of the United States, that noxious reptiles and insects were less abundant than in the Mississippi Valley, and that the soil was the most productive in the world. In short, the most sober scientists described the island in the language of the "Arabian Nights." The dry government publications lost their dryness and abounded in almost incredible statements. Every plant of the temperate and tropic zones were said to grow in Santo Domingo. A quarter of an acre of land, upon which two months' labor a year should be bestowed, would support a family of six a year. The mountains abound in gold, silver, copper, platinum, and emeralds. The country needed only a firm government and capital to make it the paradise of the world.

General Grant's deep interest in the question of annexation may be gathered from a few extracts from his message of May 3, 1871:

"I feel an unusual anxiety for the ratification of this treaty, because I believe it will redound greatly to the glory of the two countries, will be to the interest of civilization and tend to the extirpation of slavery."

He goes on to say that a European power has offered to lease Samana Bay, paying $2,000,000, and that the presence of a free, prosperous island between Cuba and Porto Rico will compel them to abolish slavery in order to keep their laborers, and that then Brazil will follow suit.

"The acquisition of Santo Domingo is desirable because of its geographical position. It commands the entrance of the Carribean Sea and the Isthmus transit of commerce. Santo Domingo will become a large consumer of the products of northern farms and manufactories. The cheap rate at which the citizens can be furnished with food, tools and machinery will make it necessary that the contiguous islands should have the same advantages in order to compete in the production of sugar, coffee, tobacco, tropical fruits, etc. This will open to us a still wider market for our products. The production of our supply of these articles will cut off more than $100,000,000 of our annual imports, besides largely increasing our exports. With such a picture, it is easy to see how our large public debt abroad is ultimately to be extinguished. With the balance of trade against us, including interest on bonds held by foreigners and money spent by our citizens traveling in foreign lands, it is not so easy to see how this result is to be otherwise accomplished."

The treaty was rejected June 30, and July 18 the news reached the city of Santo Domingo. President Baez at once replied to Congress:

"The measure will, nevertheless, succeed in the end, for it is a necessity in the progress of humanity, whose unseen director is Providence itself."

Events may yet prove this prophecy a true one. With the opening of a ship canal at Panama or Nicaragua, Santo Domingo, lying, as it does, directly in the track of vessels to and from New York, will become of importance to us. It has a better strategic position than Cuba; and, being thinly peopled, would be easily Americanized by the influx of northern immigrants. A canal across the isthmus will bring American shipping and capital into the West Indies. These little known islands will not seem so far away as they do now. The possession of them all will be almost an imperative measure for security. Even now the English islands are eager for union with us, and slight encouragement would cause the State department to be flooded with petitions for annexation. Unless these islands are annexed to us the whites will leave them; and they will become a lot of poorly governed little negro republics, whom the United States will be forced to take by the ears as a matter of police protection to our shipping passing through their waters.

One solution of our negro problem will be the civilization of these islands by the deportation of the blacks of the Southern States to them. In all probability, the black States of the American Union in a century's time will not be Alabama, Georgia, and Mississippi, but Jamaica, Hayti and the other West Indies. Baez's prophecy will be fulfilled, and Santo Domingo city, founded in 1494, the oldest city in the New World, the city of Columbus, will become the capital of one of these United States, causing its parvenu rival, St. Augustine, to lose its proud position in school histories and geographies as "the oldest city in the United States."

Madison, Mo. —*The Independent.*

CANARY ROSEWOODS.

THE following interesting paper on the canary rosewoods has been contributed Mr. D. Morris, assistant director of the Royal Gardens, Kew, to the current issue of the *Kew Bulletin*.

One of the most interesting and striking plants in the Canaries is a shrubby convolvulus, known locally as Guadil. This was in flower in the neighborhood of Orotova in the month of March last. It appears to be little known under cultivation in European gardens, although a single specimen exists in the collection of Mr. Thomas Hanbury, F.L.S., at La Mortola. This, together with a closely allied species to be presently described, is sometimes known as rose root, and is said to yield oil of roses. The Guadil (*Convolvulus floridus*, L.) is, however, more interesting as an ornamental flowering shrub than for any economic purposes to which, at one time, it may have been applied. It belongs, as already mentioned, to the bindweed order, although nothing can be less like a convolvulus in habit, and is one of the comparatively few examples of this order (containing the jalap plant, the sweet potato, the scammony, and the showy ipomœas), possessing an upright stem, and a tree-like habit. It may be described as a compact shrub from four to six feet in height, with a stout woody stem and numerous branches. The branches, especially in the young state, are white powdered, as also are the abundant linear undulate leaves. The latter are about three or four inches long, attenuated toward the petiole, with rounded and somewhat emarginate tips. The flowers are abundantly produced in large loose terminal panicles. The sepals are ovate acuminate about two lines long. The corolla is about one-half to three-quarters of an inch in diameter, and pure white. The capsule is conical and slightly villose, at the apex. It is somewhat remarkable that so striking a plant has been figured but once, and that nearly one hundred years ago.

In Jacquin's "Icones Plantarum Rariorum," t. 34, there is a long branch shown with the leaves clustered together at the apex and a few large flowers. This is scarcely characteristic of the habit of the plant, and the flowers are too large. When in flower the plant appears as if covered with newly fallen snow. It is one of the few native plants which awakens the enthusiasm of local residents at Teneriffe. As in other parts of the world, these usually strive to grow unsuitable introduced plants, and to neglect the many beautiful objects so well adapted to their soil and climate. According to Dr. Perez, the Guadil was an object of high regard by the Guanches, the aboriginal race of the island. This can be well understood, for when in flower it is one of the brightest and most attractive objects in the Teneriffe landscape. The pale, powdered green of the leaves forms an excellent background for the masses of pure white flowers. The only pity is, it is so rarely seen. In the search for rose roots for export purposes this and the allied species have been nearly exterminated in the wild state. In Teneriffe it grows from sea level up to elevations of about 1,000 feet. It evidently prefers a free porous soil and thrives in exposed situations on rocks and slopes. A fine plant was growing on a stony mound at the farm of Dr. George Perez, near Puerto Oratava, and another was seen at the Botanic Garden near the same place. In rich soil the plant appears to put on a looser habit, and when laden with flowers the panicles become almost pendulous. In this country the plant would require the protection of a greenhouse and plenty of exposure to sun and air. During the winter, when in a dormant condition, it would be necessary to keep it rather dry. It is readily increased by seed, and as it is a fast grower, it should flower in the second or third year.

Dr. Christ has published in his "Spicilegium Canariense," in Engler's "Botanische Jahrbucher," ix., p. 135, a description of a new variety of this plant, Convolvulus floridus var. densiflorus. The variety is distinguished by a more compact habit, shorter and broader leaves crowded near the ends of the branches by a shorter panicle, and by much more numerous but smaller flowers. The variety was found near Ponta de Teno, Teneriffe, by Hildebrand. For cultivation in greenhouses in this country the variety, with a compacter habit and more abundant flowers, may prove a very desirable plant.

The other species included in this note is the plant more correctly known as rose root, Lignum rhodium, or rosewood (*Convolvulus scoparius*). This, as its name denotes, is a convolvulus with the habit of a common broom. It is an erect shrub seven to eight feet high, with a few long, narrow branches and somewhat short linear leaves. The flowers are produced in many-flowered axillary cymes. The corolla is slightly plaited with a five-partite limb; it is tinged with red outside and white within. This is known locally as Lena Noel or Lena Loel. It is only rarely met with. Teneriffe specimens in the Kew Herbarium are from Guio on the southwestern slopes of the island and from Barranco Santo. It is said to be more common at Palma, but owing to the excessive digging of the roots many years ago, for export purposes, it is restricted to very few localities. There are several good figures of this plant. One of the best is that given in the *Botanical Register*, 1841, t. 43, with a description by Dr. Lindley. This was from a plant grown at Milford, near Godalming, sent by Mr. Barker Webb.

There is a single specimen of the root of Convolvulus scoparius in the Kew Museum. It is about eight inches long, two and a half inches wide, and one inch thick. The heartwood occupies about three-fourths of the entire diameter of the specimen, and is of a distinct orange yellow color, very dense, marked by closely-lying annual rings and numerous very fine medullary rays, the spaces between them being filled with small, partially open vessels. The sapwood is very much lighter in color, and is comparatively soft and easily cut. It was sent to the museum by P. Barker Webb about 1850, and still retains its rose-like smell. A sample labeled oil of rhodium is also in the Kew Museum, where it has been at least thirty-five years, and probably longer. Sir William Hooker, in his first edition of the "Kew Museum Guide," published in 1855, mentions a sample of oil in the museum at that period which is probably identical with that now existing. It is of a clear amber color, and possesses a distinct though not a penetrating odor of roses.

In Lindley's "Flora Medica" (1838), p. 400, there is the following note on this plant:

"Wood perfumed, smelling strongly of roses, yellowish fawn color, veined with red, burning readily when lighted. Taste bitter, balsamic. Yields by distillation an essential oil of bitter balsamic flavor; little used, except, according to Feé, for adulterating oil of roses."

Appended to the description of Convolvulus scoparius in Edward's *Botanical Register* (1841), t. 43, Dr. Lindley states:

"At all events the plant that yields Lignum rhodium, a wood smelling strongly of roses, yielding by distillation a bitter oil, and employed by perfumers for adulterating or altering oil of roses. The roots, which accompany the stems, as they are imported, are said to be much stronger scented than the stems. The old writers on drugs, misled by the name, imagined that this product must come from Rhodes, translating the name rhodeswood, and after hunting in vain in the writing of either ancients or moderns for the plant that yields it, arriving at the erroneous conclusion that it was the Aspalath of the Greeks. It is, however, certain that the name really signifies wood smelling of roses. Oil of rhodium is the name given to the oil obtained from this plant. The wood when powdered has been recommended to promote sneezing, and forms an agreeable snuff. It is valued for fumigation, and when burned diffuses a most delightful fragrance."

Mr. Barker Webb in a note (*Bot. Reg.*, 1841, App., p. 70) remarks:

"The roots of both the original species, Convolvulus floridus and C. scoparius, are fragrant, and yield the so-called oil of rhodium by simple distillation, though the first in a less degree, or sometimes, when young, scarcely any. The original Lignum rhodium, which came from Macedonia, was certainly Linnæus' Rhodiola rosea, figured as such by Parkinson in his 'Theatrum Botanicum,' after Lobel. 'It grows,' he says, 'in the very raggiest places on the mountains of Pangle and Ingleborough.' Soon after the discovery of the Canaries this name was transferred to Convolvulus scoparius, and afterward to several American plants. It is called in the islands Lena Noel, a corruption of Lignum aloes, and though now in little request, large quantities of it were formerly exported and the plant nearly extirpated."

The latest information on the subject is probably contained in Piesse's "The Art of Perfumery" (1879), p. 188, as follows:

"When rosewood, the lignum of the Convolvulus scoparius, is distilled, a sweet-smelling oil is procured resembling in some slight degree the fragrance of the rose, and hence its name. At one time, that is, prior to the cultivation of the rose-leaf geranium, the distillates from rosewood and from the root of the Genista canariensis (Canary rosewood) were principally drawn for the adulteration of real otto of roses; but as the geranium oil answers so much better, the oil of rhodium has fallen into disuse, hence its comparative scarcity in the market at the present day, though our grandfathers knew it well. One cwt. of wood yields about three ounces of oil.

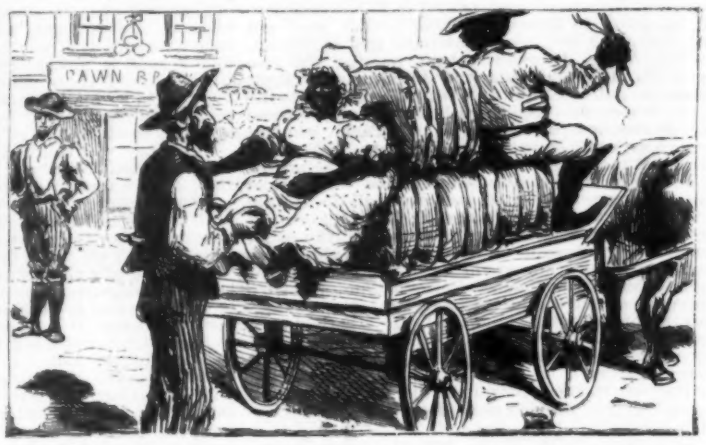
"Ground rosewood is valuable as a basis in the manufacture of sachet powders for perfuming the wardrobe."

THE COTTON INDUSTRY.

The chief interest attaching to the cotton industry of the Southern States begins in the autumn. The "boll," which bears the cotton, appears after the fall of the blossom, and is a kind of capsule, which opens when ripe, and shows from four to six locks of cotton, each lock containing three to six seeds, to which the cotton strongly adheres. As the bolls open the fields become white, and the country appears as though it was covered with snow among the green leaves. The average date of the opening of the bolls occurs about September 1, though earlier in the more southern latitudes. Then the hands are mustered for picking, and men, women and children with baskets and bags troop to the fields day after day. As they are paid by the weight they pick, their industry is unceasing. At the end of each day's labor the gatherers, who, for an adult hand, pick about 200 pounds of seed cotton, take their baskets and bundles to the weigher, who after weighing issues to each a ticket certifying the amount earned, which is usually 40 to 50 cents per 100 pounds. All this cotton is attached to the seed, which has to be separated; and it is, therefore, taken to the gin house, which is always convenient to the field. The cotton gin is a contrivance to divest the seed of its fiber—and when this is done, the lint cotton is ready for "baling," and the seed is collected to be sold, and is a valuable article of commerce, both for its fine oil and cake, and for cattle feeding purposes. This is a very large trade in itself.

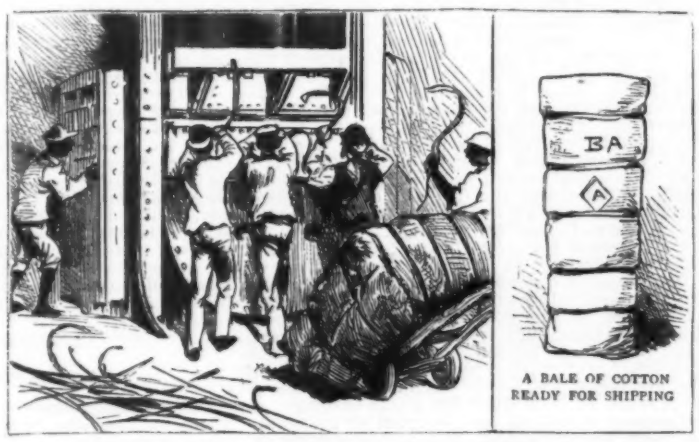
When the cotton is ginned and baled it is pressed for carriage to market—generally by hydraulic power—though for shipment it is again pressed by very powerful steam presses established at the ports. And then commences the great movement to market and port. Every road has its wagons with a few bales, every creek and river is alive with barges,

ON A TEXAS PLANTATION—NEGROES BRINGING COTTON HOME FROM THE FIELDS.



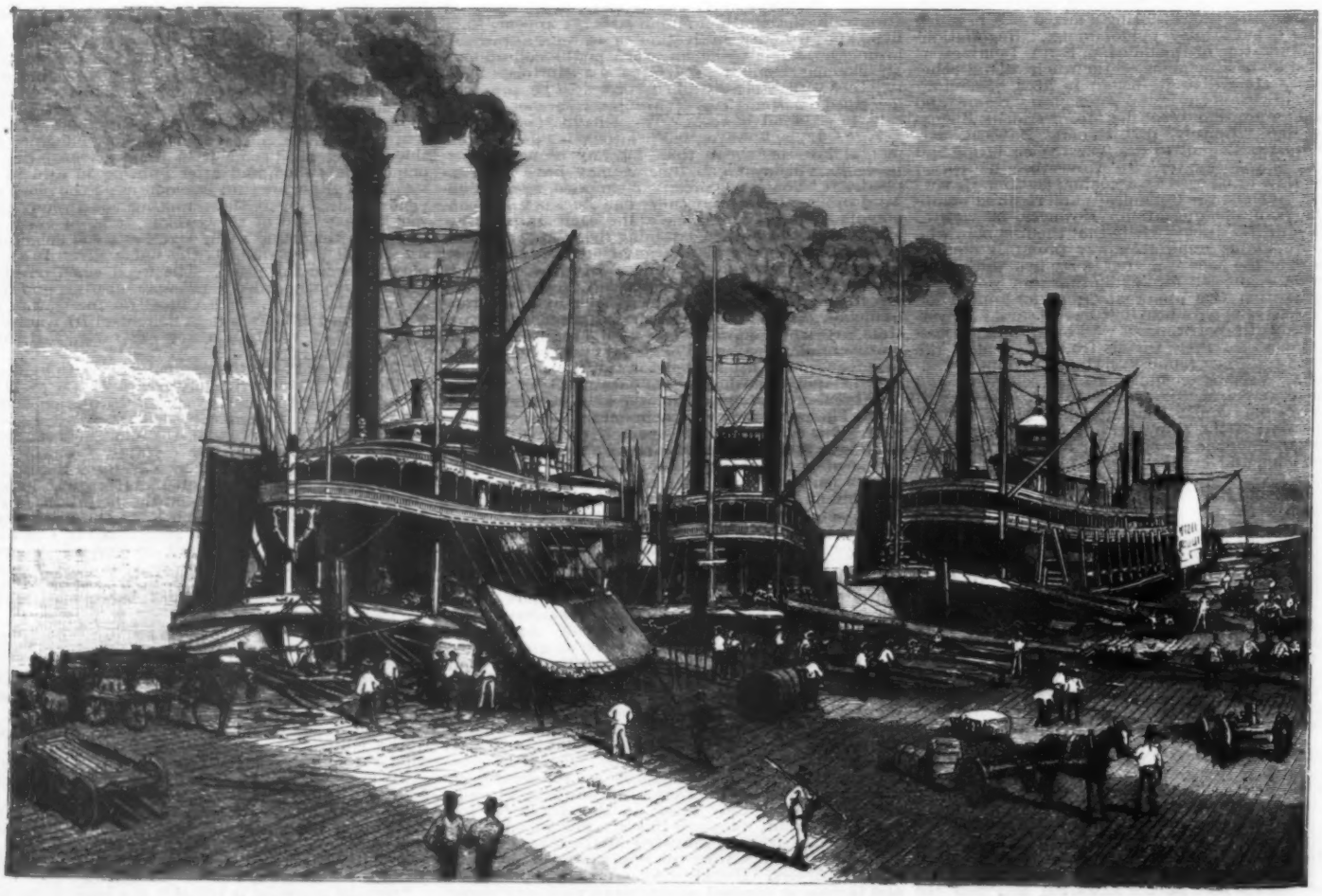
SELLING THE CROP OF COTTON—"DAT AIN'T NO SORT OF PRICE, BOSS."

NEGROES GATHERING COTTON.



A BALE OF COTTON READY FOR SHIPPING

PRESSING A BALE OF COTTON AND PUTTING ON THE IRON BANDS.



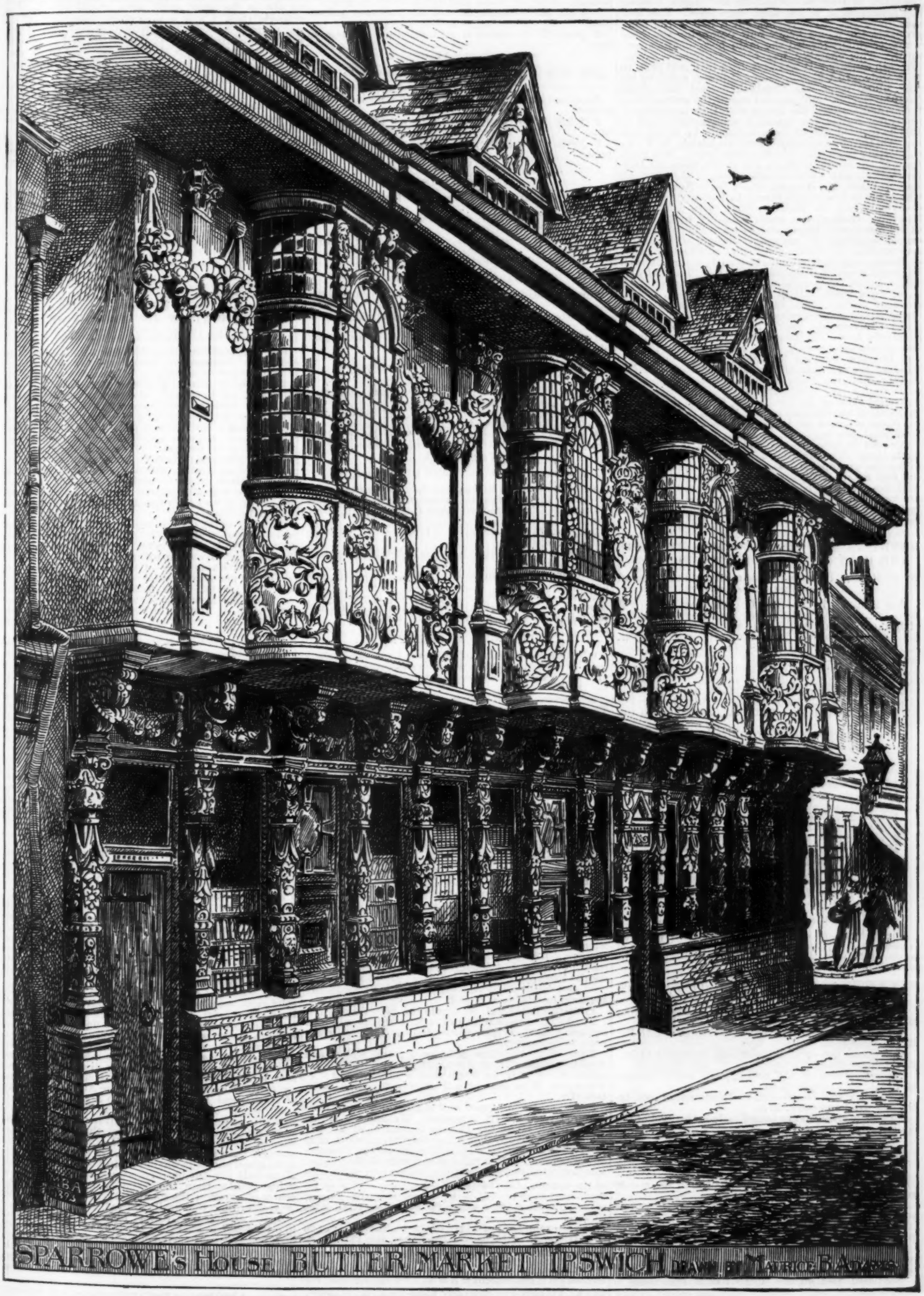
LOADING BOATS ON THE MISSISSIPPI WITH COTTON FOR NEW ORLEANS.

HARVEST TIME ON AN AMERICAN COTTON PLANTATION.—*From the Graphic.*

steamboats, and all kinds of craft. Every railway is taxed to its utmost in the transit of cotton. Down the great rivers enormous steamboats come day after day, touching at landings, where their cargoes of bales await them in thousands. In lakes and inlets of the sea the great march of the staple goes on by oddly-contrived steamships, schooners and sloops and tugs towing barges—all with the same load. Inland towns receive their bales from the plantations, and there the country buyer waits and inspects what the farmers bring by a few bales at a time on wagons. A piece is drawn as a sample, there and then the bargain concluded, cash paid over, and the purchases of the day collected in the buyers' store. Our illustrations are from sketches and photographs by Mr. C. H. Cox.—*London Graphic.*

SPARROWE'S HOUSE, IPSWICH.

THE handsome stucco front of Sparrowe's House, Ipswich, the well-known "Ancient House" in the Butter Market at Ipswich, dates from the accession of Charles II. The building itself was the work of Tudor times; but its chief glory is Jacobean. Inside, during the reign of Queen Anne, some alterations were made in



ARCHITECTURAL SKETCHES FROM THE "BUILDING NEWS."

the taste of the times, with decorations to match. At one time of day it is said that a secret chapel existed in the house for the use of the owner, whose adhesion to the ancient faith gave currency to the report as to Jesuits being housed here. The legend as to Charles II. having been concealed in the building is entirely without warrant. In 1800, or thereabout, a good roof of hammerbeam construction was opened over one of the attics, with carved arched ribs and angels flanking the principals, of which there were three. This roof may have covered a chapel, but a hall is the more probable, the rooms below now occupying the space which originally formed the main body of the apartment. This chamber has been attributed to the fifteenth century. It was 23 ft. long by about 15 ft. to 16 ft. wide. In 1567, one George Copping, aided by his wife, whose name was Elizabeth, carried out several "improvements," and paneled one of the ground floor rooms, and enriched the design with their monograms. Sparrowe owned the mansion subsequently, and in 1603 he paneled one of the apartments up to the ceiling. On the chimneypiece he cut his initials, G. W. S., supporting them with the Sparrowe arms. The main front of the house shown by our sketch faces the Butter Market, with a side elevation toward St. Stephen's Lane. When Mr. Norman Shaw built New Zealand Chambers in Leadenhall Street, just twenty years ago, everybody said his windows there were exceedingly like those which give so much piquancy to the facade of old Sparrowe's House, at Ipswich. The boldly conceived ornament in pargeted plaster, with figures representing the various continents, enriched by swags of flowers and fruit cunningly contrived, are marked by great sense of scale, though some think, at any rate, part of the details unbecomingly coarse. The royal arms, with C.II.R. in the center, form a conspicuous feature, while birds, fishes, and musical instruments complete the harmony of the composition. Atlas supports the world round the corner in St. Stephen's Lane. In the gables, St. George destroying the proverbial monster is to be noted, with Philida and Corydon figuring in other places. The overhanging cornice cuts off the lower part of the attic dormers, and the narrowness of the street prevents other than a very fore shortened view. Classic scenes, enlivened between by scrolls and foliated figures, are the *motif* of the ornamentation. Within the confines of the house is a courtyard, also plastered and having a triumphal procession on one side on a gable. The lower part is more or less modern, and is used as a book shop. The building is well cared for, and furnishes the principal object of interest in the town. On the first flooris a library, with bookcases lining the walls between the bay windows. The ceiling beams are very like those in the Nelson room. Great Yarmouth, though clearly of a later date and with circular panels for central features.—*Building News.*

HANDY TABLES OF DIMENSIONS OF JOISTS AND RAFTERS FOR COMMON PURPOSES.

By H. MAACK, Principal Academy of Architecture and Building, St. Louis.

FOR ready use in the office the following tables will be found practical and time saving. No development of formula is required, but simple multiplication of the clear span in feet by the factor hereafter given will give the desired width of joists or rafters for any span for 2" joists. For 2½" or 3" joists, it will be required to use the formula, but in the common buildings 2" joists are generally used and the free bearing length or span can be readily taken from the plans. It will therefore only be necessary to find the varying width or breadth, and this will vary according to the load or span.

The tables are computed from the formula:

$$h = \sqrt{\frac{p \times l \times 3}{k \times t \times 4}}$$

in which the letter

h = height, breadth or width of joists or rafters in centimeters.
l = length or span of joists or rafters between supports in centimeters.
t = thickness of joists or rafters in centimeters.
k = safe load, for yellow pine 60 kg., and for white pine 50 kg. per square cm. of section area with with a safety factor of 10.
1 kilogramme (kg.) = 2·2 pounds.
1 meter (m.) = 3' 3⅜" = 3·28 feet = 100 centimeters (cm.) = 1,000 millimeters (mm.)

TO FIND THE BREADTH = H.

For ready use of the tables the value "l" is already transformed into feet, and the clear span or length of joists or rafters between the supports = l, must be used therefore in feet only.

OWN WEIGHT OF CONSTRUCTION, AS JOISTS, CEILING, AND FLOORING.

Per square foot—2" × 10" joists—16" to center 12 lb., 12" to center 15 lb.

Per square foot—2" × 12" joists—16" to center 15 lb., 12" to center 18 lb.

Per square foot—2" × 14" joists—16" to center 18 lb., 12" to center 20 lb.

Per square foot—2" × 6" ceiling joists and 1" plaster and lath, 16" to center 15 lb.

Per square foot—horizontal measurement of roof, including wind and snow, 50 lb.

The loads given in the tables include the load of the construction.

TABLE I.

FOR DWELLINGS AND FACTORIES USING LIGHT MACHINERY.

Supposed load on the square foot floor space = 80 pounds.

2" joists 16" to center; h = l ft. × 0·75, (¾)" yellow pine or × 0·8, (⅘)" white pine.

2" joists 12" to center; h = l ft. × 0·66, (⅔)" yellow pine or × 0·7, ($\frac{7}{10}$)" white pine.

TABLE II.

FOR STORES.

Supposed load on the square foot of floor space = 110 pounds.

2" joists 16" to center; h = l ft. × 0·9" for yellow pine.

2" joists 12" to center; h = l ft. × 0·77" for yellow pine.

TABLE III.

FOR DANCING HALLS, HAY AND FRUIT STORES.

Supposed load on the square foot of floor space = 150 pounds.

2" joists 16" to center; h = l ft. × 1" for yellow pine.

2" joists 12" to center; h = l ft. × 0·9" for yellow pine.

TABLE IV.

FOR SALT WAREHOUSES AND WORKSHOPS USING HEAVY MACHINERY.

Supposed load on the square foot floor space = 175 pounds.

2" joists 16" to center; h = l ft. × 1·13" for yellow pine.

2" joists 12" to center; h = l ft. × 0·98" for yellow pine.

TABLE V.

FOR GRANARIES.

Supposed load on the square foot floor space = 200 pounds.

2" joists 16" to center; h = l ft. × 1·2" for yellow pine.

2" joists 12" to center; h = l ft. × 1" for yellow pine.

TABLE VI.

FOR WAREHOUSES IN GENERAL.

Supposed load on the square foot floor space = 220 pounds.

2" joists 16" to center; h = l ft. × 1·25" for yellow pine.

2" joists 12" to center; h = l ft. × 1·1" for yellow pine.

TABLE VII.

CEILING JOISTS.

Supposed load of construction, *i. e.*, joists and plastering = 15 lb. per square foot.

2" joist 16" to center; h = l ft. × 24", (¼)" yellow pine, or × 8, (⅛)" white pine.

2" joists 12" to center; h = l ft. × ¼" white or yellow pine.

TABLE VIII.

FOR RAFTERS OF FLAT AND HIPPED ROOFS.

Supposed load on the square foot horizontal = 50 pounds; this includes the construction, snow and wind loads. Measurement taken from roof plan, independent of slant of roof.

2" rafters 24" to center; h = l ft. × 0·6381, (⅝)" for yellow or white pine.

2" rafters 20" to center; h = l ft. × 0·583, (½)" for yellow or white pine.

2" rafters 16" to center; h = l ft. × 0·5, (½)" for yellow or white pine.

Collar beams must be inserted for hipped roofs, if rafters are longer than 12 feet; make same one-half the thickness of rafter, but the same width.

APPLICATION OF THE TABLES.

1st Example.—In a dwelling where joists have a clear span (l) = 16 feet, What is the proportionate width (h) for yellow and white pine, for 16" to center and for 12"?

1st Answer.—16" to center, yellow pine considered; Table I. shows for h = l × ¾" = 16 × ¾ = 12". Thus 2" × 12" yellow pine joists placed 16" to center would answer our case.

2d Answer.—12" to center, yellow pine considered; Table I. gives h = l × 0·66" or l × ⅝" = 16 × ⅝" = 10⅝". In this case 2" × 10" yellow pine would suffice, spaced 12" to centers.

3d Answer.—16" to center, white pine considered; again taking from Table I. our factor given for white pine 16" to centers, we find h = l × 0·8" or ⅘" = 16 × ⅘" = 12·8"; therefore 2" × 12", although a little weak, will do.

4th Answer.—12" to center, white pine considered; Table I. shows us h = l × 0·7" or $\frac{7}{10}$" = 16" × 0·7" = 11·2"; 2" × 12" should be used, 12" to centers.

We should not forget to arrange one row of cross-bridging for every 7 ft. of span. In case we get results like answers 2 and 3, one additional row of bridging will make up for the fraction of an inch we neglect to make use of in the nearest stock joists. The bridging does not increase the strength of the joists, but mainly acts to hold them upright and from turning over sideways. In a later paper we will see how bracing with 1" strips will increase the strength, sometimes employed for wide spans and when the time is too short to get special thickness cut by the mills.

2d Example.—Find the dimensions of ceiling joists required for the span of 15 ft.

From the Table VII. we obtain the formula:

h = l × ¼" yellow pine, or l × ⅓" white pine, 16" to centers; *i. e.*, 15 × ¼" yellow pine, or 15 × ⅓" white pine, 16" to centers.

Thus 2" × 4" yellow pine, or 2" × 6" white pine would be right. If we try on 12" centers, Table VII. shows h = l × ¼" for white pine = 15 × ¼" = 2 × 4" white pine, 12" to centers, will answer this case satisfactorily.

3d Example.—A hipped roof ½ pitch; find the rafters required. Table VIII. is needed. We find l × ⅝", or l × ¾", or l × ½" for the distance to centers, of 24", 20", and 16" respectively. The house may have a width of 26 ft. To find the length of the rafters we use the Theorem of Pythagoras. "In a right-angled triangle the longest side (hypothenuse) is equal to the square root of the sum of the squares of the two small sides," or $c = \sqrt{a^2 + b^2}$, developed from $c^2 = a^2 + b^2$, where c = the longest side or hypothenuse, a and b the other two small sides (catheti).

In our example ½ of width of the building = ½ of 26 = 13 ft. is one cathetus and the other also 13 ft. by ½ rise roof; thus the formula $c = \sqrt{a^2 + b^2}$ becomes when b = a, $c = \sqrt{a^2 + a^2} = \sqrt{2\ a^2} = a\sqrt{2}$. This last expression is convenient if a is an irregular number, for the $\sqrt{2}$ is found in most any hand-book like Kidder's on page 8, gives: $\sqrt{2} = 1{\cdot}4142$, this × a (= 13) = 18·38 ft. length of rafters. The formula $c = \sqrt{2\ a^2}$ would have been more convenient here for $2a^2 = 2 \times 13 \times 13 = 338$ and the $\sqrt{338} = 18{\cdot}38$ ft., found on page 13 of Kidder.

If only an approximate answer for the length of rafters is desired, which would fully satisfy our figuration, we may use the improper fraction ⅞ and multiply by one of the equal small sides of our right-angled triangle, thus: ⅞ × 13 = 9⅛ = 18½ ft., near enough for our purpose, as we take only the nearest full feet (18) into consideration. h = 18 × ⅔" = 12", or 2" × 12" rafters, 24" to centers. h = 18 × ½" = 10½", or 2" × 10" rafters, 20" to centers. h = 18 × ½" = 9", or 2" × 8" rafters, 16" to centers.

The rafters being over 12 ft. in length, it will be required to insert collar beams. If we get sufficient tie at the foot of the rafters to the joists, we may design the collar beams 8 ft. above floor. On the supposition that outside wall and top of rafter meet in floor height, we obtain the length of the collar beams as follows: Whole height of roof 13 ft., less 8 ft. to bottom of collar beams = 5 ft. multiplied by 2 = 10 ft., the length of collar beams; for twice the rise = span by ¼ pitch roofs. This last holds good in this particular case only, but proportion will solve it under all circumstances. Entire height to entire span as is partial height to collar beam, *i. e.*,

$$13 : 26 = 5 : X$$
$$X \times 13 = 5 \times 26$$
$$X = \frac{5 \times 26}{13}$$
$$= 10 \text{ feet.}$$

THE LIMITATION OF ENGINE SPEED.*

By CHARLES T. PORTER.

THE practical limitation to high rotative speed in stationary reciprocating steam engines is not found in the danger of heating or of excessive wear. The causes of both these, it is now well understood, are to be looked for in defects of design or construction, commonly both, as they generally go together, and where these do not exist to a degree which is of practical moment, a bar to the proper employment of higher rotative speed appears long before a tendency to heat or wear is to be observed. Correct designs are now generally followed in both the fixed and the moving parts of steam engines, and a high degree of truth is really attained in their construction, so that it has come to be a simple matter to make engines which can be run at very high speed quite free from either of these difficulties.

Contrary to the general belief, no objection to very rapid rotation is afforded by the development of centrifugal force in the fly wheel or band wheel. This the following exposition will make clear.

This centrifugal force of one pound making one revolution per minute, in a circle of one foot radius, is 0·000341 pound. This force varies directly as the radius in feet, *R*, and as the square of the revolutions per minute, *r*. Hence the expression $Rr^2 \cdot 000341$ gives the centrifugal force in terms of the weight *W*. This is a simple and convenient formula.

A handy formula is desirable for the centrifugal force developed in each one square inch of section of the rim of a fly wheel. This is obtained as follows: In a cast iron wheel of one foot radius, measured to the center of gyration of the rim, the value of *W* for each one square inch of rim section is 19·6. This number, multiplied into 0 000341, gives 0·0066836 as the centrifugal force, in decimals of a pound, of this ring at one revolution per minute. As both the centrifugal force and the weight vary directly as the radius, we have the expression

$$(Rr)^2 \times 0{\cdot}0066836$$

for the centrifugal force developed in each one square inch of cross section of the rim of any cast iron wheel. For example, this centrifugal force in a wheel five feet in diameter making three hundred revolutions per minute is 3759·5 pounds.

$$(2{\cdot}5 \times 300)^2 \times 0{\cdot}0066836 = 3759{\cdot}5.$$

This is the sum of the centrifugal stresses, exerted equally in all directions in the plane of revolution. What is the measure of the tendency of these forces to burst the wheel?

Answer.—One-fourth part of these forces, nine hundred and forty pounds, is resisted by the tensile strength of two opposite sections of the rim. This strength, for good American iron, may be taken at twenty thousand pounds per square inch, aggregating forty thousand pounds in the two sections, giving a factor of safety of 40·4. So this wheel may be run at double speed, six hundred revolutions per minute, with a factor of safety of 10.

The wheels of high speed engines have generally solid rims, and no case of their bursting has, I believe, ever been known. Disasters from this cause have been confined to engines not designed to be run at high speed, and have sometimes occurred when the speed was only slightly accelerated above the normal rate. In these cases the wheels have been built in segments, with surprising disregard of necessary strength in the flanges and bolts by which the segments were held together. The American Society of Mechanical Engineers will do a good thing if it shall adopt ten as the factor of safety in tensile strength, to be recommended by it for all mechanical work, and shall also recommend that in segmental wheels the joints be made, if anything, a little stronger than the section of rim. In applying the formula given above, it will be safe to take as the value of *R* one-half the outside diameter of the wheel. This being greater than the diameter measured on the center of gyration, the computed centrifugal force will be greater than that really exerted.

Again, an objection to very high speed is not found in a tendency to knock on the centers. In a properly designed and constructed engine, in which the valves are correctly set, and which is run by steam, high speed tends to silent running. Noise from bad design or bad work, from insufficient lead given to the valves

* Read before the World's Engineering Congress.

and from water in the cylinder, is excluded from consideration.

It is admitted with pride that the bad consequences of these defects are aggravated by high speed. This revelation of them has wrought an entire change in engine construction, not yet completed, and even makers of slower speed engines have largely profited by it. But it is obvious that there is now no excuse for their existence. The only legitimate cause of knock on the centers is loose boxes, and knock from this cause is softened as the speed is increased, and at extremely high speed will disappear entirely, owing to the force of the steam at these points being absorbed in overcoming the inertia of the reciprocating parts.

Again, vibration is not an objection to very high speed, because it is an easy matter so to design and construct an engine and balance the running parts that it shall be free from vibration at any speed whatever.

Again, very high speed is not objectionable, *per se*. If an engine runs in silence, completely free from vibration, without any tendency to warm, and without wear of any running part, its very speed renders it an object of especial admiration, even to those to whom such speed is new. Whenever extremely high speed in a steam engine has caused any other feeling in the beholder than that of admiration, it has always been the case that it has been attended with something annoying, a noise or a jar, or some uncomfortable action which ought not to have existed.

All this being true, there still remain two considerations of a controlling nature which require that the rotative speed of the engine shall be kept within moderate limits.

The first of these is that engines ought not to be run as fast as they can be. It must on reflection be obvious to every one that an engine should be capable of running, and that too with entire satisfaction, so far as its motion is concerned, a great deal faster than it is run. This is the solid ground of security and confidence. It means peace and comfort, and helps to make men sleep well o' nights. It means long life to both engine and builder. I do not know anything to which the ancient maxim, *in medio tutissimus ibis* is more directly applicable. Observe the force of the superlative, *tutissimus*, considered as a positive statement, "in the middle course you shall go most safely." That is just what we want in mechanics, in all our progress, to go most safely.

The second objection to the employment of extremely high speed is a very serious one indeed. It is the large amount of waste room in the port which is required for proper steam distribution. In the important respect of economy of steam the high speed engine has thus far proved a failure. Large gain was looked for from high speed, because the loss by condensation on a given surface would be divided into a greater weight of steam, but this expectation has not been realized. Far from it. The performance of this class of engines shows, instead, a positive and in some cases a large loss in economy. For this unsatisfactory result we have to lay the blame chiefly on the excessive amount of waste room. It has been already pointed out by Harris Tabor that the ordinary method of expressing the amount of waste room in the percentage added by it to the total piston displacement is a misleading one. It should be expressed as the percentage which it adds to the length of steam admission, and then every one would see what a serious thing it is. For example, if the steam is cut off at one-fifth of the stroke, 8 per cent. added by the waste room to the total displacement means 40 per cent. added to the volume of steam admitted. Under these circumstances, it is obviously the duty and for the interest of builders of high speed engines to adopt every expedient for reducing the amount of waste room that can be done consistently with the proper admission and discharge of the steam. For this, the first requisites are moderate piston speed and longer stroke.

Engines of four, five and six feet stroke may properly be run at from seven hundred to eight hundred feet of piston travel per minute, but for ordinary sizes I would recommend and urge that six hundred feet per minute be taken as the limit of piston travel under all circumstances. This would give from three hundred revolutions per minute with twelve inches stroke to one hundred revolutions per minute with thirty-six inches stroke, with which purchasers ought to be satisfied. I would ask builders, in their own interest, to resist the temptation to get the utmost out of a given engine, and to set their faces like a flint against the demand for short-stroke engines, which shall occupy but little room and from which the required power can be got by speeding up beyond the limit here proposed. But I am met with the objection that in this class of engines large waste room is a necessity to prevent breakdown from water in the cylinder—that of the two alternatives of waste of steam in this way and broken cylinder heads and pistons, purchasers prefer the former. I confess that I am thoroughly disgusted at the engineering which puts purchasers of engines in such a dilemma as this. Getting rid of water in the cylinder seems to be the prerequisite to any attempt to reduce the amount of waste room. Then by all means let it be the first object of builders of high speed engines to get rid of all possibility of water in the cylinder in an amount capable of doing any harm.

THE TIDE INDICATOR AT ROUEN.

THE ascertaining of the height of the tide is a matter of considerable importance from the standpoint of the service of ports. Tables calculated in advance are capable, indeed, of giving the level of the tide in a port at every hour of the day, but such tables are hardly within the reach of everybody. Now in an ocean port everything depends upon such hour of the tide, which is essentially variable. Employers and employes have the same interest in knowing it daily for the general distribution of work. The Rouen Chamber of Commerce, desiring to furnish such information to all in the most useful manner, undertook the construction of an apparatus that might render to the public the same services as the tide gauge, the indications of which serve as a basis to engineers for the study of the nature of tides. It was necessary to so arrange things that the indications could be read from a distance. The site was all determined upon. The installation of hydraulic power, substituted for steam for the different motors of the port, had necessitated the establishment of a water accumulator of large dimensions in the very center of the maritime port, and, for the accommodation of this accumulator, it had been necessary to construct a very high tower upon the right bank of the river.

It was resolved to put this tower to profit by installing at its summit the dials of the tide indicator and of a regulating clock designed to furnish the time in regard to the level of the tide (Fig. 1). These two data, in fact, complete each other, for the ascertaining of the level of the tide is of no importance unless the time is known. The question of the tide having no interest except for the port, it was decided that out of the four dials of the tower, only one, that which faces

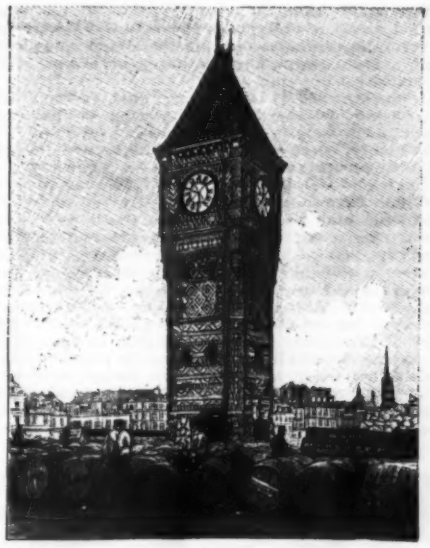


FIG. 1.—TIDE INDICATOR AT ROUEN.

the port, should give the level of the tide, while the others should give the time on the city side.

The installation, executed by the Messrs. Chateau, was copied from the arrangement employed for the transmission of the level in the ordinary tide gauges usually constructed by these engineers. A well in proximity to the river communicates with the water through a canal. In this way, the waves have no influence in the way of causing the float to oscillate. The float, which is of iron plate, is attached to a copper cable whose extremity winds over a drum. This latter is mounted at the end of a horizontal rod 25 meters in length, carried here and there by supports provided with three rollers, in the interior of a subterranean canal. The rod transmits its rotary motion through a bevel gearing mounted at its other extremity, in the interior of the tower, to a vertical rod 13 meters in length. Fig. 2 shows the arrangement of this mechanism.

The bevel gearing is shown in the upper right hand corner. It is the rod last mentioned that transmits its motion to the axis of the handle through a bevel gearing. Upon this same axis is mounted a small drum around which runs the wire of a counterpoise designed to suppress plays of the gearing and keep the copper cable of the float taut. The diameters of these bevel wheels and drums are so calculated that the hand shall make a complete revolution of the

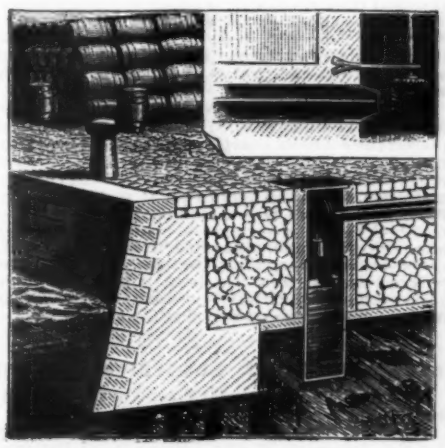


FIG. 2.—FLOAT OF THE TIDE INDICATOR.

FIG. 3.—DIAL OF THE TIDE INDICATOR.

dial when the level of the sea varies by 8 meters. The diameter of the dial is about 2 meters, which permits its indications to be seen at a distance (Fig. 3).

The apparatus has operated for more than a year without getting out of order. The dials, which are of opal glass, are arranged so as to be illuminated at night. The regulator is of the type used in large clocks of precision and designed to command large dials without sensible variations. This kind of movement, called also constant force movement, because it completely suppresses the influence of accidental resistances upon the regularity of the clock, consists in employing as a motor of the escapement wheel a small weight wound up every thirty seconds by the main wheelwork. It is clear that in this manner the escapement is protected against accidental influences.

The clock is provided in addition with an automatic distributer of currents, with inversion after each emission, in order, later on, to permit of installing electric dials at any distance whatever from it, as well as the arrangement for setting the clock that was inaugurated many years ago at Paris for the unification of time in large cities. In Rouen especially, the numerous clocks of the Court of Judicature always agree perfectly, owing to this system, which has just been adopted, also, for the unification of time in the two lyceums of the city.—*La Nature.*

THE BERING SEA DECISION.

A DECISION has at length been rendered in the now celebrated Bering Sea controversy. The decision is, speaking broadly, against the United States on all the specific legal points in controversy, but the tribunal has judged it proper that the sealing industry should be regulated, and to that end a majority of the arbitrators have adopted a series of regulations which they regard as necessary outside of the jurisdictional limits of the two governments. The disposition of most of those in the United States who have followed the proceedings closely appears to be to regard the outcome as a practical victory for the stand taken by this country as to the protection of seals, while Great Britain has succeeded in defeating the United States on technical legal grounds.

In order to a clear understanding of the scope of the decision just rendered, it will be well to recall the questions presented to the arbitrators. These were as follows:

1. What exclusive jurisdiction in the sea known as the Bering Sea, and what exclusive rights in the seal fisheries therein, did Russia assert and exercise prior and up to the time of the cession of Alaska to the United States?

2. How far were these claims of jurisdiction as to the seal fisheries recognized and conceded by Great Britain?

3. Was the body of water known as the Bering Sea included in the phrase "Pacific Ocean," as used in the treaty of 1825 between Great Britain and Russia, and what rights, if any, in the Bering Sea were held and exclusively exercised by Russia after said treaty?

4. Did not all the rights of Russia as to jurisdiction and as to the seal fisheries in Bering Sea east of the boundary in the treaty between the United States and Russia of the 30th of March, 1867, pass unimpaired to the United States under that treaty?

5. Has the United States any right, and, if so, what right, of protection of property in the fur seals frequenting the islands of the United States in Bering Sea, when such seals are found outside of the ordinary three-mile limit?

It was further provided that if the determination of the foregoing questions as to the exclusive jurisdiction of the United States should leave the subject in such a position that the concurrence of Great Britain should be necessary to the establishment of regulations for the proper protection and preservation of the fur seal in or habitually resorting to Bering Sea, the arbitrators should then determine what concurrent regulations outside the jurisdictional limits of the respective governments should be necessary, and over what waters such regulations should extend.

Upon the first point submitted, as to the jurisdiction of Russia, six out of the seven arbitrators, including Judge Harlan, one of the arbitrators on the part of the United States, decided that by the ukase of 1821 Russia claimed jurisdiction in the sea now known as Bering Sea to the extent of 100 Italian miles from the coasts and islands belonging to her, but that in the course of the negotiations which led to the conclusion of the treaty of 1824 with the United States and the treaty of 1825 with Great Britain, Russia admitted that her jurisdiction in said sea should be restricted so as to reach a cannon shot from shore, and that from that time up to the time of the cession of Alaska to the United States Russia never asserted or exercised in fact any exclusive jurisdiction in Bering Sea, or any exclusive rights to the seal fisheries therein beyond the ordinary limit of territorial waters. In regard to the second point, as to the recognition of Russian claims by Great Britain, the same arbitrators decided that Great Britain did not recognize or concede any claim on the part of Russia to exclusive jurisdiction as to the seal fisheries in Bering Sea outside the ordinary territorial waters. In reference to the third point, the tribunal decided that the body of water now known as Bering Sea was included in the phrase "Pacific Ocean," as used in the treaty of 1825 between Great Britain and Russia. Upon the fourth point the tribunal decided that all the rights of Russia to jurisdiction and the seal fisheries in Bering Sea east of the boundary in the treaty of 1867 between the United States and Russia passed unimpaired to the United States under that treaty. The fifth point was,

of course, the most important of the legal questions submitted, involving as it did the question as to the extent of the right of the United States to protect property in fur seals. Upon this point the arbitrators, with the exception of those from the United States, decided that this country had no right to the protection of or property in the seals frequenting the islands of the United States in Bering Sea when the same were found outside the ordinary three-mile limit.

As will be perceived, these decisions of the arbitrators, especially the last one, left the subject in such a position that the clause in the arbitration treaty regarding the adoption of regulations for the protection of fur seals applied. Accordingly a majority of the arbitrators comprising the members of the tribunal, with the exception of the two arbitrators for the United States and the Canadian representative, Sir John Thompson, agreed to a series of regulations as necessary outside of the jurisdictional limits of the two governments at issue. These regulations are as follows:

Article 1. The United States and Great Britain shall forbid their citizens and subjects respectively to kill, capture or pursue at any time or in any manner whatever the animals commonly called fur seals within a zone of sixty miles around the Pribylov Islands, inclusive of the territorial waters, the miles being geographical miles, sixty to a degree of latitude.

Article 2. The two governments shall forbid their citizens or subjects to kill, capture or pursue in any manner whatever during a season extending in each year from May 1 to July 31 inclusive, fur seals on the high sea in that part of the Pacific Ocean, inclusive of Bering Sea, situated north of the 35th degree of north latitude, or eastward of the 180th degree of longitude from Greenwich until it strikes the water boundary described in Article 1 of the treaty of 1867 between the United States and Russia, following that line up to Bering Straits.

Article 3. During the period of time in the waters in which fur sealing is allowed only sailing vessels shall be permitted to carry on or take part in fur-sealing operations. They will, however, be at liberty to avail themselves of the use of such canoes or undecked boats propelled by paddles, oars or sails, as are in common use as fishing boats.

Article 4. Each sailing vessel authorized to carry on fur sealing must be provided with a special license issued for the purpose by its government. Each vessel so employed shall be required to carry a distinguishing flag prescribed by its government.

Article 5. The masters of vessels engaged in fur sealing shall enter accurately in an official log-book the date and place of each operation, the number of and the sex of the seals captured daily. These entries shall be communicated by each of the two governments to each other at the end of each season.

Article 6. The use of nets, firearms or explosives is forbidden in fur sealing. This restriction shall not apply to shotguns when such are used in fishing outside of Bering Sea during the season when such may lawfully be carried on.

Article 7. The two governments shall take measures to control the fitness of the men authorized to engage in sealing. These men shall have been proved fit to handle with sufficient skill the weapons by means of which seal fishing is carried on.

Article 8. The preceding regulations shall not apply to Indians dwelling on the coast of the territories of the United States or Great Britain carrying on fur sealing in canoes or undecked boats not transported by or used in connection with other vessels and propelled wholly by paddles, oars or sails, and manned by not more than five persons in the way hitherto practiced by the Indians; provided that such Indians are not employed by other persons, and provided that when so hunting in canoes or undecked boats the Indians shall not hunt fur seals outside the territorial waters under contract to deliver skins to anybody. This exemption is not to be construed to affect the municipal law of either country, nor shall it extend to the waters of Bering Sea or the waters around the Aleutian Islands. Nothing herein contained is intended to interfere with the employment of Indians as hunters or otherwise in connection with sealing vessels as heretofore.

Article 9. The concurrent regulations hereby determined with a view to the protection and preservation of the fur seals shall remain in force until they have been wholly or in part abolished or modified by a common agreement between the United States and Great Britain. Said concurrent regulations shall be submitted every five years to a new examination in order to enable both governments to consider whether, in the light of past experience, there is occasion to make any modification thereof.

Taken in connection with the course of the proceedings before the tribunal, the outcome of the arbitration suggests the reflection that the case of the United States was not so well framed as it was argued. The questions as submitted to the arbitrators seemed to lay particular stress on the subject of exclusive jurisdiction over Bering Sea as a whole. It is, however, rather late in the day for the doctrine of *mare clausum* to be seriously considered by international lawyers, and, as we pointed out in the course of the proceedings, the counsel for Great Britain made the most of the legal points involved, of course to the disadvantage of the United States. On the other hand, with commendable foresight, the counsel for the United States devoted little attention to this branch of the argument, though they took pains to declare untrue the assertion that the United States wished to declare Bering Sea a closed sea. They concentrated their efforts mainly upon the need of regulations to prevent the destruction of seal life and the property interests of the United States therein. The effects of this course are seen in the regulations adopted by the tribunal, though these were dissented from by the representatives of the United States and of Canada.

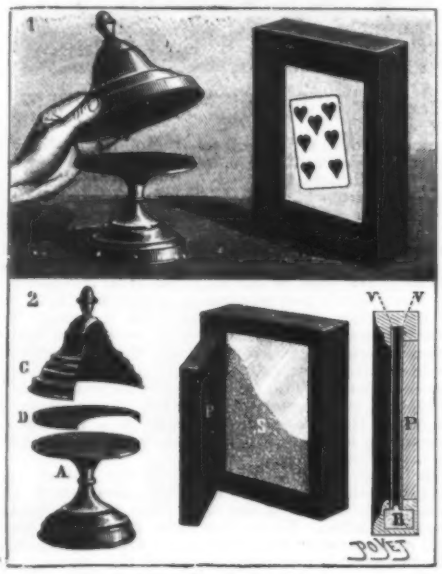
In the first place the killing, capture or pursuit of seals at any time or in any manner is forbidden within a zone of sixty miles around the Pribylov Islands. In the next place sealing is prohibited from May 1 to July 31 in that part of the Pacific Ocean, inclusive of Bering Sea, situated north of the 35th degree of north latitude, or eastward of the 180th degree of longitude from Greenwich until it strikes the water boundary described in Article 1 of the treaty of 1867 between the United States and Russia. Furthermore, only sailing vessels specially authorized are to be allowed to take part in sealing operations, and the use of nets, firearms or explosives is forbidden in fur sealing, with the exception of shotguns when used in fishing outside of Bering Sea during the season when such may lawfully be carried on. These regulations should operate to limit very materially the wanton destruction of seal life. To this extent the result of the arbitration is of a nature to commend itself to the judgment of mankind at large, and as a matter of fact the United States has secured a substantial gain. At the same time it will serve no useful purpose to overlook in an optimistic spirit the fact that on the grounds of technical right the contentions of the United States were found untenable.

THE SAND FRAME TRICK.

THE sand frame is a very ingeniously constructed little apparatus which is employed in different tricks of prestidigitation for causing the disappearance of a card, a photograph, a sealed letter, an answer written upon a sheet of paper, etc.

In appearance it is a simple, plush-covered frame, the back of which opens with a hinge behind a glass, which, at first sight, presents nothing peculiar.

In reality, there are two glasses separated from each other by an interval of 3 millimeters. The lower side of the frame is hollow and forms a reservoir filled with very fine blue sand. In the interior the door is covered with blue paper of the same shade as the sand. The card, portrait, or letter that is subsequently to appear is placed in the frame in advance, but, in order to render it invisible, the latter is held vertically, the reservoir at the top. The sand then falls and fills the space that separates the two glasses, and the blue surface thus formed behind the first glass seems to be the back of the frame. In order to cause the appearance of the concealed object, the frame is placed vertically with the reservoir at the bottom, and covered with a silk handkerchief. In a few seconds the sand will have disappeared. The door that closes the back may be opened by a spectator and the frame shown close by,



THE SAND FRAME.

provided that it be held vertically in order to prevent the sand from appearing between the two glasses.

Fig. 2 shows the frame as seen from behind. The door, P, is seen open, and at S is seen the sand falling between the two glasses. In the section at the side, V and V, are the two glasses, P, the door, and R, the reservoir.

We have supposed here an experiment made by means of the small foot, A, upon which a spectator has placed the seven of hearts. The card passes into the frame. To tell the truth, it is removed by the cover, C, along with the thin disk, D, that covered the foot, A, and upon which it was placed. It will be said that we have here to do with a double bottom. Allow the cover, C, before covering the card, and the foot, A, after the experiment is finished, to be examined. Is the cover asked for again? One will hasten to show it without saying that the back edge of the table has just been struck with it in order to cause the disk, D, and the card to fall on to a shelf.—*La Nature.*

LEGAL UNITS OF ELECTRICAL MEASURE.

THE recent International Electrical Congress at Chicago adopted the following recommendations:

Resolved, That the several governments represented by the delegates of this International Congress of Electricians be and they are hereby recommended to formally adopt as legal units of electrical measure the following:

As a unit of resistance the international ohm, which is based upon the ohm equal to 10^9 units of resistance of the C. G. S. system of electromagnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14·4521 grammes in mass, of a constant cross sectional area and of the length of 106·3 centimeters.

As a unit of current the international ampere, which is one-tenth of the unit of current of the C. G. S. system of electromagnetic units, and which is represented sufficiently well for practical use by the unvarying current which, when passed through a solution of nitrate of silver in water and in accordance with accompanying specifications, deposits silver at the rate of 0·001118 gramme per second.

As a unit of E. M. F. the international volt, which is the E. M. F. that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampere, and which is represented sufficiently well for practical use by $\frac{1}{1434}$ of the E. M. F. between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of 15° C., and prepared in the manner described in the accompanying specification.

As the unit of quantity the international coulomb, which is the quantity of electricity transferred by a current of one international ampere in one second.

As the unit of capacity, the international farad, which is the capacity of a conductor charged to a potential of one international volt by one international coulomb of electricity.

As the unit of work the joule, which is 10^7 units of work in the C. G. S. system, and which is represented sufficiently well for practical use by the energy expended in one second by an international ohm.

As the unit of power the international watt, which is equal to 10^7 units of power in the C. G. S. system, and which is represented sufficiently well for practical use by the work done at the rate of one joule per second.

As the unit of induction the henry, which is the induction in the circuit when the E. M. F. induced in this circuit is one international volt while the inducing current varies at the rate of one ampere per second.

On the standard of light:

Resolved, That this committee, while recognizing the great progress realized in the standard lamp of Von Hefner-Alteneck and from important researches made at the Reichsanstalt, and also recognizing that other standards have been proposed and are now being tried, and that there are serious objections to every kind of standards in which an open flame is employed; it is therefore unable to recommend the adoption at the present time of either the Von Hefner lamp or the pentane lamp, but recommends that all nations be invited to make researches in common on well-defined practical standards, and on a convenient realization of an absolute unit.

THE GAS ENGINE AS APPLIED TO ELECTRIC LIGHT WORK.*

By GEORGE A. FARWELL.

BY request of your president I consented to prepare a short paper, to be read at this meeting, on "The Gas Engine as Applied to Electric Light Work;" but I do not expect to present for your consideration anything that is not comparatively well known, as the subject has repeatedly been discussed in technical papers.

I shall not refer to the advantages or disadvantages of the different types of gas engines in use, but simply give you some details of my experience with the one I have had running for the past year in the station of the Waukesha (Wis.) Electric Light Company.

This is a 100 horse power, two cylinder, Otto gas engine. The cylinders are horizontal, one directly above the other. The connecting rod from the upper piston takes hold of the crank pin, while the connecting rod from the lower piston is attached to the upper connecting rod some distance back of the pin. The supply valves to the cylinders are disk valves, opening inwardly, and are held in their seats by light spiral springs.

The exhaust valves are flat valves, which are opened by a cam. The governor regulates the speed of the engine and controls the admission of gas to the cylinders. There is a gas bag between the meter and the engine to insure an even pressure.

The gas pipe from the meter to the gas bag is 4 inches in diameter, and from the gas bag to the engine 3 inches in diameter. The gas is ignited by an electric spark produced from a 4 cell Edison Lalande battery. A water jacket surrounds the cylinders to prevent overheating, and there is an exhaust pipe for each cylinder.

Naturally the motion of the engine would be somewhat unsteady, on account of the force of the explosions, but this disadvantage is entirely overcome by a heavy pulley and fly-wheel on the engine, and by the use of a countershaft carrying a heavy balance wheel. The engine runs at 160 revolutions per minute, and the balance wheel 000. This insures steady motion at the dynamos.

The speed of the engine can be increased or decreased at will by manipulation of the governor.

While the engine is running, the amount of gas it consumes is regulated by the governor for the varying load it carries.

It is a simple matter to record correctly actual expense in generating power for running dynamos with a gas engine. I have a countershaft, to which are belted a 100 horse power engine, one 100 horse power steam engine, one 80 light arc dynamo, one 75 light arc dynamo, and one 600 light incandescent dynamo. By the use of clutch pulleys I can run any one or any two of the dynamos with either engine, or I can run any two of the dynamos with either engine, and the other dynamo with the other engine; or I can run the three dynamos with both engines at the same time.

I generally start up with the gas engine running the commercial arc dynamo and the incandescent dynamo. When it is time to turn on the street lights I start the steam engine, switch the commercial arc dynamo and the incandescent dynamo off the gas engine on to the steam engine, and the street lights on to the gas engine. I have too much load for either one of my engines to carry it all, but when it is so that one engine can carry it, I make the gas engine do the work.

It is a well-known fact that when illuminating gas is burned in a gas engine to drive a dynamo very much more light can be produced than can be produced by burning the same quantity of gas in burners in the usual way.

For instance, 4 gas burners burning 5 feet per hour, and 18 candle gas, will give light equal to 72 candles. The same amount of gas burned in a gas engine will produce an electric arc light of 2,000 candle power.

An average of six different tests, made by myself during the month of June, to ascertain the cost of gas

* A paper read by Mr. George A. Farwell, of Waukesha, Wis., before the Madison (Wis.) meeting of the Northwestern Electrical Association.—*American Gas Light Journal.*

consumed by a 100 horse power Otto gas engine, per horse power per hour, resulted as follows:

To arrive at the cost of the gas used by a gas engine when it is located at the gas works, one would have to ascertain just what the gas at his own works, and at a particular point in its manufacture, costs; then, none of the cost of distribution should be counted. In this instance, to carry the example to completion, I have figured the cost at 50 cents per 1,000 cubic feet.

The amount of gas consumed in 10 hours' run of gas engine, driving 53 arc lights of 2,000 candle power each, on a 9½ mile circuit, was 10,920 cubic feet, or 1,092 cubic feet per hour, or 20·6 cubic feet of gas for each lamp, which, at a cost of 50 cents per 1,000 cubic feet, is 0·0103 per lamp per hour, or per horse power per hour. Figuring shafting, dynamo, line and lamps, I found that the whole, taken together, represented practically 53 horse power.

In another test, where I ran 36 arc lights and 300 incandescents, representing 60 horse power, the consumption of gas was 1,400 cubic feet per hour, or 20·3 cubic feet per horse per hour, or 0·0115.

In a test where I ran 36 arcs and 425 incandescents, representing 80 horse power, the consumption of gas was 1,600 cubic feet per hour, or 20 cubic feet per horse power per hour, or 0·1. These tests show that as the load increases, the cost per horse power decreases.

Following is a report of two 50 horse power Otto gas engines, made in October, 1889, in the State of Wisconsin:

Facts and Figures Concerning One Month's Run of Two Otto Gas Engines, 65 Horse Power, Driving 52 Arc Lamps, 2,000 Candle Power each, 11 Miles Circuit.

October, 1889; total time, 180 hours and 55 minutes; total gas consumption, 264,000 cubic feet. Gas consumption per lamp hour, 23·53 cubic feet. During that month 4·84 cubic feet of gas were made from each pound of Youghiogheny coal; thus the coal consumption per lamp hour would be $\frac{23·53}{4·84} = 4·8$ lb. of coal.

Cost.

To produce 264,000 cubic feet of gas consumed in engines, there were required 54,545 lb. or 27·272 tons of coal, at $3.15 = ...		$85 86
There were obtained from this amount of coal, as by-products:		
Coke, 33 bushels per ton = 890 bushels of 40 lb.; 50 per cent. used as fuel, leaves 450 bushels, at 10 cents.....	$45 00	
Tar, 13 gallons per ton = 351 gallons, at 10 cents	35 10	80 10
Leaves total cost for fuel to drive 52 arc lamps for the entire month of October.....		$5 76

There was no extra expense for labor on account of the additional amount of gas produced for the gas engines, nor on account of operating them. The handling of this fuel occasioned no extra expense. With steam power, not only coal must be handled at special outlay, but also ash. The amount of the fuel, already less than that required by steam power, has its cost materially reduced, and in some cases almost entirely offset, by revenues from coke and tar. Where no revenues whatever are obtained from by-products, *it will still pay to use gas power*, and for this reason:

Because the handling of fuel can be done in gas house without extra expense, but will call for extra labor when consigned to boiler house.

The following is a quotation from *Practical Electricity*,* published at Boston:

"At the 18th annual meeting of the New England Association of Gas Engineers, held in Boston February 15 and 16, a series of questions were propounded for the consideration of members. One of these questions reads as follows:

"How will the gas engine work to supply power for an electric light plant? How does it compare in economy with a steam engine?

"Mr. A. M. Norton, of Nashua, N. H.—We have a 15 horse power Otto engine. From the moment we started it the lights burned very steadily, and have all the time. We have 10 lights on it. They are the steadiest arc lights that I ever saw. Probably it will not carry 10 lights as cheaply as a smaller engine with the same number of lights; but it now runs 10 full arc lights and uses 275 feet of gas per hour with the lights all on.

"Mr. C. F. Prichard, of Lynn, Mass.—I have paid considerable attention to the running of the Otto gas engine in a general way, but not for producing electric light. It struck me, as Mr. Norton stated, that the steadiness and reliability of the engine for running the electric light lamp has been thoroughly demonstrated. Mr. Norton states that he uses 275 feet of gas to run 10 lights an hour; 275 feet would be 11 cents per hour—that is, it would be 1·1 cent per horse power per hour, assuming it takes one horse power per light. I think it would be difficult to find a steam engine running so small a plant which would work down to four pounds of coal per horse power hour, considering the conditions under which they run. Considering the coal that is used to bank the fires to keep them, and the quantity used in starting the fire, I think it is doubtful if the average of the electric light plants will run on less than six pounds of coal per horse power; but, for the sake of comparing with Mr. Norton's figures, let us take four pounds of coal per horse power per hour. Figuring that out at $4 50 per ton, we have the result of one cent per horse power per hour. Mr. Norton figures the gas at forty cents per thousand, bringing it down to 1·1, which gives us 0·1 of a cent difference in just this simple case, and we have still to allow for the cost of water for the boiler and for the labor of firing. The actual expense, as I believe they figure it, is 1·1 cent per hour. In that case we have the cost identical, whether he runs with the gas engine and uses gas at first cost or uses a steam engine with coal at $4.50 per ton. This shows to me that we are able, even at the present time, with a gas engine to compete with the steam engine for power; and it seems to me, with increased resources and the possibility of cheap fuel gas to supply our gas engines in the future, the steam engine has got to go for running electric light plants."

The discussion, which was continued at some length, I will not repeat.

It is worth the while of electrical engineers to look carefully into the question of large gas engines. Too much attention is being given to small details of electrical construction. It does not matter so much whether a dynamo gives 95 or 96 per cent. of efficiency, if there is a consumption of twenty pounds of coal per delivered electrical horse power hour. The brain work spent in securing the odd one per cent. in the dynamo would be more profitably invested in studying the behavior of various engines and boilers under the very abnormal conditions that hold in central stations. The question of idle boilers is a serious one. An engine at half load takes too much steam, but it is little good cutting this steam down if the boiler burns almost as much coal when it supplies less steam. Central station conditions are about as bad for boilers and engines as they possibly can be. Now, consider the case of the gas engine. Allowing that no one but gas companies would think of working electric light stations with coal gas, yet when supplied with water gas, or producer gas, the gas engine of to-day can compete with the steam engines at full load.

Under the conditions that prevail in central stations, the gas engine has the advantage, in that when the engine stops, the consumption of fuel stops also. There is no water to boil before starting and no ashes to remove. Gas engines are less expensive than steam engines and boilers, and can be started and stopped without trouble when wanted.

They take less room, make no smoke and are cheaper to run. Larger gas engines are being turned out with water gas plants and with gas producers. The time will probably come when gas engines will displace steam engines altogether in electric light stations.

* See *American Gas Light Journal*, vol. 38, issue of March 16, 1893, p. 175.

INDUCTION AT GREAT DISTANCES.

AT a meeting of the Royal Society of Edinburgh, Mr. C. A. Stevenson, C.E., read a paper "On Induction at Great Distances through Air and Water, without the Use of Parallel Wires," his object being to explain a method which might be found useful for establishing communication electrically between ships at sea. His original idea was to lay down a cable in

Fig. 1 Electrostatic

Fig. 2. Electromagnetic

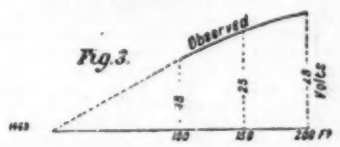


Fig. 3.

which a varying current would be maintained; ships when near it would, with suitable instruments, detect its presence and verify their own position. Having been informed that no instrument was known capable of detecting the currents which at present could be used in submarine cables, he had made further experiments, and had succeeded in making two such instruments, which would act through 30 fathoms of water. The first of these instruments consisted simply of two coils of copper wire, quite uninsulated, one of which was placed in the water at the bow and the other at the stern of the boat (see figure). If the coils were joined by a wire in which a telephone was interpolated and the boat moored nearly at right angles to a submerged cable, any electrical changes in the latter could be heard in the telephone. If the boat was in such a position that the two coils were equidistant from the cable, no sound could be heard in the telephone. With the coils 10 ft. apart, the electrical changes in an insulated cable, one end of which was coupled to a De Meritens machine, giving 80 volts, could be heard in the telephone when the boat was 340 ft. distant from the cable. It was impossible to ascertain at the time whether the effects could be detected at a greater distance. The second instrument consisted simply of a coil of insulated wire surrounding an iron core. When a telephone was put up in circuit with this coil, the electrical changes in a wire 40 ft. distant could be detected. The wire was $\frac{1}{16}$ in. in diameter, 200 ft. long, and the electrical changes in it were caused by making and breaking contact with six dry cells. With 12 cells the changes could be detected through 60 ft. of salt water.

UNDERGROUND WIRES FOR ELECTRIC LIGHTING AND POWER DISTRIBUTION.*

By Prof. D. C. JACKSON.

THE author spoke of the obvious advantages of placing wires underground, and mentioned the two methods in use in this country, viz., (1) solid or built systems and (2) drawing-in or conduit systems. A complete subway system consists of three parts, the conduit, the drawing-in manholes, and arrangements to get at the cables for service connections. There are at present in successful use in America four typical forms of conduit: cast or wrought iron pipe, cement lined sheet iron pipe, tile, terra cotta or clay pipes and wooden tubes. Of these, glazed terra cotta is most used, in sections three feet long, with rectangular ducts, each containing at least three cables. It is water tight and nearly gas tight and the glaze has quite a high electrical resistance. The conduit should be laid with its top about 2 feet below the pavement when in concrete; without concrete, at about 3 feet. The tile conduit should be laid in a bed of from 2 inches to 6 inches of concrete, and covered with concrete to that depth, so that when the whole has hardened it is like a continuous set of stone ducts. The top may be further protected by creosoted board when the conditions make it necessary. Joints between the sections are made either by wrapping the joints with several layers of burlap strips soaked in hot asphalt or by means of a tile sleeve over the joint, which is cemented on. The latter joint is usually used when the conduit is laid in concrete, and in laying the conduit it is then usually sufficient to simply bring the sections together in a line in a trench, and fill in with concrete.

House services are sometimes taken off from this type of conduit by means of hand poles, in front of each house, using a subsidiary duct of iron pipe running into the basement; and sometimes the service wires are taken from the manholes and carried into each block by the subsidiary duct, whence they are distributed overhead from the roofs or otherwise. The all-underground method is the best, but it is more expensive; so it is less frequently used.

The experience of those who have used tile conduits seems to be very favorable, especially in the smaller cities. In Washington it is highly praised, both by the telephone and electric light companies, and telephone companies in Baltimore, Chicago, Pittsburg, Milwaukee, and other cities consider it successful.

The simplest of all conduits, and one which is used quite generally, is a common wrought iron gas or steam pipe, either laid bare in the ground or in a bed of concrete. Ducts are usually of 2 inch to 3 inch pipes, and since a 3 inch pipe will carry four ordinary electric light cables, the system is economical of space in the streets. Joints in the pipe are made with a sleeve screwed on with a vanishing thread which is cut so that the ends of the pipe come close together inside the sleeve. The sections of pipe are generally 20 feet long. The great advantage iron pipe has over all other forms of conduit is its flexibility. Experience in New York and Chicago proves that cables can be pulled easily around several bends with radii of 3 feet or less.

The best method of laying iron pipe ducts is in concrete, with the pipes about 1½ inches apart. It is sometimes best, as an extra precaution against mechanical injury, to box it in at least on the top and sides with creosoted plank. Iron has been found to have no bad effects on the lead covers of the cables, either while drawing in or by chemical action after they are in, although it is possible for rust to so fill up the ducts that the cables cannot be easily withdrawn. The only bad feature of this form of conduit is its magnetic qualities. If an alternating current is carried through an iron duct, and the return wire is in another duct, the self-induction is greatly increased and the loss of pressure is considerable. In one case where the effect of iron conduits upon the loss of pressure in electric light cables was tested, the loss due to impedance was found to be a considerable factor. Mr. Preece finds a fall of pressure of two volts with a current of 7·2 amperes and resistance of 0·0088 ohm, when the conductors are thus arranged. He concludes that the losses are due to hysteresis and eddy currents in the pipe, and is consequently opposed to the use of iron for this purpose. A satisfactory commercial remedy for the defects is to put both sides of the circuit into the same duct, and as close together as possible. A great many cables used in some of the cities are made with the outgoing and incoming wires duplexed together for this purpose.

Wood conduits are used considerably in Philadelphia. The thickness of the walls is about 1¼ inches, the top usually covered with a 2 inch plank for extra mechanical protection. The commonest form of wood conduit is made up of 4 × 4 inch pieces of wood with a 3 inch hole bored through from end to end. These are jointed either by a male and female union or by simply butting the ends together. For a preservative of the wood, oil of coal tar, carbolineum and other compounds have been used. One of the greatest advantages claimed for the wood conduit is its accessibility. The greatest disadvantage is the chemical effect of the preserving compound on the lead covering of the cables. The lead is entirely destroyed by chemical action in a short time when in the presence of wood preservative, unless it is protected by hemp braiding, alloying with tin, etc. Since the life of braiding is limited, and tin does not alloy evenly with lead, the rate of depreciation of cables in these conduits is usually great. Wood conduits properly treated with preservatives should last thirty years, and untreated fifteen years.

The only type of conduit which is being used on a large scale is the cement-lined iron pipe. The tubes for this conduit consist of a tough sheet iron shell, riveted, and lined with ⅝ inch of pure cement, no sand being used, and the inside being carefully smoothed. The pipes are made in 8 foot lengths and of various diameters. The weight per foot of 3 inch duct (which is generally used) is about 5 pounds, as compared with 7½ pounds for wrought iron pipe. It is claimed that the pipe is water and gas tight, and proof against acids and alkalies. Distribution is always effected from manholes or handholes, the subsidiary ducts being generally 1 inch wrought iron pipes.

Its main advantages are durability, smoothness and cheapness as compared with iron pipe.

For electric light cables, especially where several companies occupy the same conduit, larger manholes are necessary. An ordinary standard size is 6 feet square and 7 or 8 feet deep. When the conduit consists of few ducts near the surface, a much smaller hole, three or four feet deep, may be used, with a large cover, so that workmen can practically stand in the street while working at the cables. The walls should be of brick, laid in cement, and there should be a 6 inch concrete foundation. The cover should be of cast iron on a ring casting set on the brickwork and well fastened by anchor bolts. Where double covers are used the inner one should be screwed down in a rubber gasket. The cables should be hung against the sides, that they may be readily reached. Handholes are either on the surface or buried. The latter are usually best, as so many covers along a street are objectionable. Some method of draining should be

* Abstract of a paper read before the International Electrical Congress, August 21-25, 1893.

provided, but in large cities gas is even more to be guarded against than water, and the pressure in the conduits should be kept greater than that in the street by means of blowers as used in New York, where about 1 horse power per mile of subway is required at the blower, delivering about 500 feet of air per hour to each manhole. In some places where the blower is not used, the manhole is connected by a pipe to a hollow electric light pole, which acts as a chimney.

THE WORLD'S ELECTRICAL CONGRESS.

THE meeting of the Electrical Congress at Chicago last month was a memorable affair. Many valuable papers were read and interesting addresses delivered.

PROF. ELISHA GRAY'S OPENING ADDRESS.

I esteem it an honor of the highest distinction to be permitted to call this International Congress of Electricians to order, coming as you do from all parts of the world, and distinguished, as many of you are, for your contributions to the world's progress through the medium of science, theoretical and applied.

The time and place for the assembling of this congress are most opportune. Men who represent the best thought and the best work of the world are here. The scientists who seek to unlock the secrets of nature and open to man new fields for research and further add to the sum of the world's knowledge, are here. The achievements of the world's thought, the world's skill, the world's genius, are all about us; worked out in machines, in fabrics, in painting, in sculpture and architecture.

The whole atmosphere is surcharged with the activities of all nations, material and intellectual. We cannot help but draw inspiration from such surroundings and have our minds so attuned for the work before us that the very best results shall come from our deliberations. We have here to-day men who represent almost every phase of electrical work; men who come from the school, the college, the university, the laboratory of the scientist and from the commercial walks of life. And then we have with us that other much abused but necessary citizen, the inventor, the man who is, in some degree, a combination of all the rest, and is the product of daylight toil and midnight oil. It is fitting that these varied capacities should come together in a great convention like this.

The smallest of us will learn much that we could not in any other way, and the greatest will go away broader, if not wiser, men. What is true of nations is, in a sense, true of individuals. A nation cannot be great and attain to a high degree of civilization unless her people are surrounded by a large variety and high quality of material, moral and intellectual forces. These forces are so related that in the grand march of progress they cannot be separated without lowering the grade of the final result. The individual cannot be great in his vocation or profession if he always lives and works within narrow lines; every science is more or less related to every other science, so that to know any one thoroughly it is necessary to know something of all. In other words, to be a good specialist one must begin by being a good generalist.

We meet to-day within the lines of one great and growing profession, that of electricians; and one that is growing daily in importance. The science of electricity has so many ramifications that it is impossible for any one man, unassisted, to compass the whole in a lifetime. We have assembled, then, all workers in one great but divided field. Some of you are devoted to pure science, some to science and practice and some to pure practice—while all are necessary factors comprising one complete whole. The pure scientist cannot carry on his work without the aid of the man who applies scientific discovery to useful machines and instruments of research; and the great world cannot be benefited by the discoveries of scientists and the application of inventors without the man of practice, who is the medium between the inventor and the user. Let us, then, expect that the results of this congress will be far-reaching; that it will impress itself upon the lives and work of many of its members, and that all of us will gather fresh inspiration by this commingling of kindred spirits.

The rapid strides that have been made in electrical science and electrical invention in the last twenty-five years have marked a new era in our civilization, and this age may well be denominated the electric age. Who knows what the next quarter of a century will bring to us through the medium of electricity? To some people it seems as if the limit was nearly reached; but who knows? A certain professor of physics who lived and taught some fifty years ago, thought even at that time that the limit had been reached, if we may judge by a lecture given on a certain occasion to his class. He had been explaining the experiments of Franklin, who, as the Fourth-of-July orator puts it, "caught the forked lightning from the clouds, tamed it, and made it subservient to the will of man." At the conclusion of his lecture on electricity, which consisted of a description of the celebrated kite experiment, he said: "Young men, you were born too late to witness the growth and full development of that great science—electricity." If the good professor had been allowed to peer from behind the veil and watch the progress of the science since his demise, he must be possessed with a growing conviction that he made a mistake when he said "too late," and that he should have said "too early."

The grand results that have thus far been attained were not accomplished by any one nation or individual. We, as Americans, are proud of our native land—the land of Franklin, Morse, and Henry; but we are also proud of our fatherland, and we believe that the fatherland is just a little proud of us—although we neither of us say this too often or too loud. The fatherland of America is all the civilized world, outside of its own borders. We are proud of an ancestry from which spring such men as Faraday and Lord Kelvin, such men as Ampere and De la Rive, such men as Galvani and Volta; and last, but not least, we are proud of an ancestry that produces such men as our honored guest Dr. Von Helmholtz.

To you, gentlemen, who come from the cities and hamlets within the borders of our own land, I need not extend a welcome to America, for you are a part of the sixty-five millions of people who live under the protection of this grand old flag of ours; but I do extend to you a hearty welcome to Chicago, the commercial metropolis of America.

To you who come from foreign shores, not only Chicago but America extends a royal welcome. We welcome you on behalf and in the name of the electricians of America; and finally, we welcome you in the name of our own beloved science, which knows no geographical boundaries, but includes the whole brotherhood of man.

For myself as chairman of the committee of organization, I wish to extend thanks to my fellow workers who compose the various sub-committees, at home and abroad, including both those appointed by the advisory council and the American Institute of Electrical Engineers, for the invaluable aid they have given me, without which this congress could not have been organized.

My work as head of the organizing committee ends here, and I now surrender this congress into your hands, feeling assured in advance that the work will be well done; for bad work coming from such an able and distinguished body of men as this is would be an incongruity that is unthinkable.

PROF. THOMSON'S ADDRESS.

I thank the congress very much for calling me to the chair at this time, even though it be but the temporary chairmanship. I certainly would be fully repaid at any time in any gathering of this kind in doing anything I could to favor its plans and to carry on its pursuits.

We are gathered here as representatives of the departments of that grand science which, though not in its infancy—as we sometimes see the newspapers state—has yet the power of youth and the power of an unceasing youth, as we believe, in the time to come. It is that science which, when we visit the grand collection of man's industrial achievements at Jackson's Park, we are proud of; it is that science which has made such a collection and such an exhibition even possible. If an attempt had been made fifteen years ago to produce the results which are there exhibited, where should we have been? Everywhere that you go you will find evidences of the work of electricity—all accomplished within this brief period of years. Yet many of the principles of them were known long before, and we bow to the army of workers who have brought about this grand success. Many of the prominent ones have passed away.

In relation to a remark made by Dr. Gray, that there was not very much more to learn, that somebody had been born too late, I called to mind an expression I found in an old book in regard to electricity. I think it was a book on physics printed a hundred years ago. The statement in the book was that the advances had been so rapid and so numerous that it really did not seem that there was any direction in which discoveries were likely to be made in electricity. All that the book dealt with was the old frictional machine, the Leyden jar and a number of luminous experiments on vacuum tubes, etc. Shortly after the publication of that book there came along the whole of the discoveries in voltaic electricity, opening up that very wide field, which has gone on expanding up to the present time, and which will go on, following the development of that field and opening up what we call the dynamo-electric field, which is really an extension or expansion of the voltaic theory. But to-day we recognize no such distinctions. The electricity of to-day is one and the same thing, whether you see the current used by thousands of amperes to weld masses of metal together or whether you see the lightning striking from a thunder cloud to the earth. In both you see the same thing, only in one instance you have no pressure and enormous volume, just as a great river flows on without having any apparent head or anything to force it along; and in the other case you have enormous pressure and a very small amount of volume.

It is the glory of all science that it works not only to discipline and enhance the intellectual advancement of man, but it also confers practical benefit, and it is the peculiar glory of electrical science that, study it, delve in it merely for mental discipline, and you will find it one of the best exercises imaginable. If you work in it for practical uses, you wi l find that it has the possibility of ramification into innumerable fields. It is almost a universal science.

Can you wonder then that we are enthusiastic, that we are proud to work in a field of this kind? It is the modern field; the field which will in the future give us the power to do things which to-day we cannot conceive possible. Beginning with small things, beginning sometimes with merely theoretical developments—developments of very little practical interest—we find as time goes by those very things becoming of practical use. And so it is with science in all its departments; no part of it can be considered as useless from a practical standpoint.

Let us then unite in making this congress a memorable occasion, a celebration, as it were, of the past fifteen or twenty years and the years that have gone before that period in the grand developments which have taken place in electrical science. The best way to do that is to exchange ideas and discuss points of difference of opinion, or of unanimity of opinion, if you please, and endeavor to spread information abroad and extend the sphere of our knowledge.

We have with us to help out in this grand and good work men of distinction from every clime. We have some with us who have earned the highest distinctions, and I am glad to say that they will be of the greatest assistance to us Americans who attend largely to practical work, in keeping us out of altogether practical ruts.

The order of business for to-day will be first the election of a temporary secretary.

Prof. F. B. Crocker, of New York, was unanimously elected temporary secretary of the congress.

The chairman announced that the next business would be the appointment of a committee on permanent organization, and in accordance with this suggestion the following named gentlemen were unanimously appointed: Dr. T. C. Mendenhall, Washington, D. C.; Prof. Benjamin F. Thomas, Columbus, Ohio; Dr. Louis Duncan, Baltimore, Md.; Dr. S. P. Thompson, England; Prof. E. Hospitalier, France; Dr. A. Lindeck, Germany; Dr. A. Pellaz, Switzerland.

THE CHAIRMAN: I am at liberty to call upon a gentleman to say a few words to you in connection with the electrical part of the World's Fair as seen from a foreigner's standpoint. The gentleman whom I shall call upon is undoubtedly known to us all by reputation. He is a man who has combined in himself not only pure science but its application; a gentleman who has been a worker in the field for many years.

ADDRESS BY PROF. WILLIAM E. AYRTON, OF LONDON.

There is one thing which I certainly am not, which Prof. Thomson has told you I was, namely, a foreigner; for no Englishman can possibly be a foreigner in America.

In asking me to say a few words about a stranger's—not a foreigner's—impression of the electrical display at the Exposition, I imagine that the committee of the congress considered it was desirable to precede the more solid meal of mathematical technicalities, which we electricians are compelled to feed upon, by something a little light; and, therefore, it has fallen upon me to supply the radishes and the caviare which form the first course of the intellectual banquet which the committee has provided for you.

In order that one may judge of this country, it is most important to free one's self from the conservative prejudices so common to an inhabitant of the old world. I have, therefore, endeavored, as far as lay in my power, to look upon things here with an open mind. If by chance any of my conclusions may seem a little pointed, I ask you to remember that caviare is made intentionally a little piquant to stimulate your appetite for the more solid dishes that will follow.

Chicago is a long way from the sea, and therefore a vast territory has to be crossed before one can get here. The stranger's impressions of the electrical display of America begin to be formed long before he arrives at the White City. The glow lamps which he sees lighting even your scattered houses, the arc lamps which he sees burning in your country lanes, the electrical tramways rapidly carrying the working population of your cities into healthy suburbs in the evening when their day's work is over—all these fill the stranger with admiration, and he feels pleased to know that you have no board of trade to control your affairs. However, when in a city like Baltimore he finds that the roads which are destined to become electric have been converted into Alpine mountain passes by the construction of electric tramways; when he sees jumbled up on the same posts telephone, telegraph and high-pressure electric light wires, sometimes with insulation a little defective, he becomes reconciled again to the dominion of Whitehall, and he takes comfort to himself in the thought that high-pressure transformers are not stuck like flies on the house walls in his own country. When he learns that the load on the down-town electric mains in New York is at a maximum at two in the afternoon, his mouth waters at such a paying load line, and he would rush to take shares in such a prosperous undertaking, except for the recollection that one or a ten per cent. dividend come to much the same thing when there is no currency whatever to pay the dividend declared. In Pittsburg, Cleveland, Lynn and Schenectady the stranger is much astonished at the courtesy with which he is shown every detail in a factory, as well as at the magnitude of the undertakings. His expectations are roused to such a pitch that he expects when he reaches Chicago to find an electrical display which will cast all previous electrical exhibitions in the shade.

Well—take the stranger into the Electricity building blindfolded, so that his judgment may not be warped by the glories of the outside surroundings, and leave him there for awhile. If he be candid and if he can muster up courage to say a word which might cause pain to those whose kindness has made them dear to him, he will say that he is a little disappointed. He is disappointed that the world has not better answered the invitation to show in the Electricity building what it could do. If he is an Englishman, he is not only disappointed, but rather ashamed of his country. Even looking at the Electricity building from a purely American standpoint, if you will allow me to say so, I do not think the exhibits inside quite do this country justice. We have all heard of arrangements that are being made to utilize 300,000 horse power at Niagara—the greatest engineering feat probably that the world has ever seen—but in the Exhibition, I think I am right in saying that not a model or a plan can one find of the work that this country is doing, and which will, when accomplished, redound to its praise. It might seem a small thing, compared with that, to transmit a little over a hundred horse power 100 miles with a commercial efficiency of 75 per cent.; but at Frankfort the stranger really did see that done; and although that was but a small thing compared with what America is doing at Niagara, one would like to have seen something on the spot. In other words, the stranger feels that the real electrical display of America is not in the Electricity building, but in every street where there are trolley wires, in every town and village where there are electric lamps; and where is the town in this country where there are none?

But if the stranger be thoughtful, he is not disappointed. At Frankfort it was what was inside the electrical building that dazzled his mind. At Jackson Park it is what is outside the Electricity building that rivets his attention. One feared that the bustle and hurry of this country would not allow time for the appearance in the programme of the development of the cultivation of those charms that Americans come to Europe to witness; but when I saw your Exhibition, when from the top of the Manufactures building I looked down at night on that "court of honor," on that tracery of electric lamps, more beautiful in its realization than could have been even the dream of the writer of the Arabian Nights, then I felt sure that in that great living hospitable heart which throbs in the breasts of the all-practical, go-ahead people of this country there must be some nook where lurks the belief that, powerful as is machinery, all-powerful as is electricity, the song, the poem, the echo of the statue that lives when the bones of its creator have crumbled into dust, are even more powerful still in forming the history of humanity.

But your exhibition makes me hope that the love of art and beauty for their own sakes, which we have hitherto regarded as the heritage of poor and oppressed races like those of Italy, Hungary, and Russia, will become the heritage of this great free nation.

There is one exhibit in the Electricity building which struck me very forcibly—an exhibit which does not appear in the catalogue—and that is the young American electrician. Deeply interested as I am in the teaching of the application of science to industry, nothing could have pleased me more than to see the value that you electrical engineers of this country attach to the bright lad who has had good college training; and while great feats have been achieved and are being achieved by veterans like Edison, Gray, Elihu Thomson, and Westinghouse, and others, you trust the development of your electrical enterprises in the hands of those whose skill merits your confidence and whose youth does not cause you distrust.

As one grows older, age, like electric self-induction, wipes out the minor ripples in the current of one's past life, but certain prominences, though rounded by time, are never obliterated. In the current of my life there will ever be one epoch towering far above all others—the epoch labeled "Chicago, 1893."

Chairman Thomson escorted to the president's desk Dr. Von Helmholtz, the honorary president-elect, who was received with cheers and a rising salute by the congress. Chairman Thomson introduced the eminent scientist as follows:

It now becomes my most pleasant duty to present to you the honorary president selected by the congress, a man whose name and fame are really known wherever science is taught: a man whose varied achievements in all departments have made him the type of the man of general science; a man whose work has gone to make many of the sciences what they are to-day—one of whom it would be difficult to say whether in optics, in sound, in electricity, in the laws of motion, and the conservation of energy he had done the most work. An optical congress might claim him; a congress of music and sound might claim him; and a congress of electricians has claimed him, and we have him.

It is to his fundamental studies on the laws of fluid motion, on the laws of conservation of energy, that we electricians must look. These studies, carried on long ago, laid the foundation for the work of others who came after him. We find much of the work of even the great master, Maxwell, depending on the labors of the gentleman whom I am to present to you. I now have the honor to present to you as your honorary president, his excellency Dr. Von Helmholtz.

The congress rose and saluted their distinguished honorary president, who, when the cheering subsided, addressed the body as follows:

DR. VON HELMHOLTZ'S ADDRESS.

I must say that I am almost overpowered by the excessive honor which you have given me, for I am not quite sure that I possess the merits necessary to fill the distinguished position to which you have called me. I have been occupied with electricity, that is true. It may be that in your selection here you have given to old age the privilege of being honored more than usual, even if the merits of the individual are doubtful.

I think I am the most aged of the electricians who are present here. The beginning of my career was at a time when the phenomena of electricity were apparent only by the most delicate experiments in the laboratory. Where we to-day move great machines of the mightiest power, in that old time when I began to study electricity we could only move little magnetic needles suspended on the finest silken thread that we could obtain. We balanced two such needles on the opposite poles in order to get any token of an electric current, or even the most delicate index of electrical current, such as was obtained by Volta from the frog. He could do nothing but make an oscillation or contraction. He could not move the slightest apparatus, but he saw that there were visible currents. At that time we had no constant electro-motive force. We were obliged to work with simple battery elements of copper and zinc without sulphate of copper, and elements which altered with every movement; which had in the first instance a great electro-motive force and then went down, down, down, so that in some instances there was scarcely any force at all, or only traces of the former force.

Now all that is changed. In the beginning of my career, we knew nothing of the great discoveries of Faraday of induced currents, which have developed now into currents that can drive the mightiest machines.

The present generation—if I may include myself in the present generation—the present generation has seen a greater development of science of every kind, and principally of electric science, than any generation before it. The history of the world and the history of science has grown very rapidly during our lifetime. It is a great pleasure for us old men to see now what electricity has reached in its new stages and to admire the newest developments which are collected on this festival occasion here in your great exhibition. Permit me to thank you for the great honor you have conferred upon me.

CHAIRMAN THOMSON: I am sure that the congress will join me most heartily in the wish that Dr. Von Helmholtz may for many years to come be included in this generation, that he may live to see the grander accomplishments which are to be achieved without doubt in our favorite science.

I have no need to introduce the next gentleman, Dr. Gray, to the Chicago public. He is perfectly well known in the city here as the type of the practical inventor and scientific man. He was prominent early in working out systems of transmission of intelligence. I remember, personally, that when I was a mere boy I saw an exhibition of his harmonic telegraph, which interested me very much indeed. It came some years before the telephone, and if the telephone had not come, I am certain that the electro-harmonic telegraph of Dr. Gray would have been doing a large amount of work to-day. But Dr. Gray not only invented the harmonic telegraph, but he has also been connected as an early pioneer with the invention of the telephone itself. I remember seeing at that early exhibition of which I spoke one experiment which gave such promise of talking that it almost sounded as though it did talk. It was an experiment in which Dr. Gray simply held his hands on a little zinc cylinder and the sound came from his fingers or the cylinder—a contact vibration. The sound was given at the other end by a diaphragm, and breaking and making contact very similar to the Rice telephone, but the sounds were so near talking that I thought there was very little to be done to make it talk. Dr. Gray very soon after that did that thing which would have made such an instrument talk.

Dr. Gray has presented to the world, after a long siege of hard work, the telautograph, which is certainly a marvelous instrument; one which enables us to take up a pen at one station and produce a written record or drawing—in fact, to produce any system of lines you choose—at a distant station, several instruments being operated at the same time.

There is no one more fitting to preside as permanent chairman of this congress than Dr. Gray. He has had the arrangements for the congress for a long time in his hands, and he has worked faithfully and energetically to have the congress as successful as possible. I can testify to that personally, having been in communication with him. I now have the pleasure of introducing to the congress your permanent chairman, Dr. Elisha Gray.

Chairman-elect Gray was received with hearty applause, in response to which he said that he was not going to make another speech. "I wish simply to heartily thank this congress," he said, "for the honor that it has conferred upon me, for it is an honor to act in this capacity, even though it be a subordinate one. It is an honor to act in connection with one who is so distinguished as the gentleman whom you have made your honorary president. I do not need to introduce to this congress the vice-president from Great Britain, because wherever on earth the telegraph extends and where the science of electricity is known, everybody knows William H. Preece, chief engineer of the London postal telegraph system. I will call upon him to say a few words to this congress."

Vice-President Preece was greeted with cheers, upon the subsidence of which he addressed the congress as follows:

W. H. PREECE'S ADDRESS.

I feel very highly honored in having conferred upon me the position of vice-president for that very tiny little spot on the ocean that is called Great Britain. This is not the first time I have crossed the Atlantic. This is not the first congress that I have attended in America. This is my third visit here, and I have never yet left these shores empty handed. I have always taken something away with me; not surreptitiously, for I think it will be acknowledged that we in England have always handsomely paid for that which we have taken from you.

I have the greatest possible hopes for the success of this congress. Congresses do an infinity of good; they make us all travel on the same track. We never get shunted into wrong quarters if we rely upon the ideas that have been inculcated at these congresses. Electricity in all its branches is cosmopolitan. As your chairman implied, it has no geographical limitations. It knows no nation. It has but one language; and the object of our meeting here is to try to make that language a little more perfect. Its growth and history have been guided by the principle of continuity and by the principle of evoluti on, and we are here to show how the modern electrician has planted the ideas of Franklin and Henry and Fara day and Maxwell and others on the history of the pres ent, while we are still working hard to cultivate those seeds planted at our feet by such men as Helmholtz. But there is one other function that a congress fulfills, and one which I trust we will all do our best to fulfill, and that is to secure among ourselves that al one which makes life pleasant and happy—feelings of friendship and of amity. In my small career I have found that the friendships made abroad at these congresses have been lasting, and I can look around me here and see several of those whom I have met at other congresses, and whom I know that I shall be able to call my friends as long as we exist.

One of the earliest lessons that I learned in this lesson-teaching country was this: Never prophesy unless you know. Now, I will venture to prophesy this: That when in future ages men shall look back to the annals of history to discover those epoch-marking events that have made history, there will be no assemblage of electricians that will be more indelibly engraved on the marbles of time than this great Electrical Congress of 1893, held in Chicago.

Chairman Gray introduced Vice-President E. Mascart, of France, who delivered a brief address in his native tongue, thanking the congress for the honor conferred upon him and proph esying the greatest good to come from the deliberations of the distinguished scientists.

EXTRACTION OF OILS.

Linseed Oil.—After a *résumé* of the methods of manufacture and processes of purification of linseed oil, the authors give the following data:

Specific gravity at 15° C.		0·9342
Fatty acids	Point of fusion	20°—21° C.
	" solidification	16°—17° C.
Temperature rise		122°—126° C.
Iodine number		158·7—159·78
" "	of fatty acids	159·85
*Saponification number		190·2—192·7

Heydenreich's reagent produces an orange coloration with brown striæ, and those of Hauchecorne and Brullé a reddish brown, the oil remaining liquid.

Linseed oil is frequently adulterated with siccative and non-siccative oils, as also with mineral and animal oils and resins.

Colza and cotton seed oil can be recognized by the lowering of the iodine number and the temperature rise; the latter oil also gives a black coloration with silver nitrate. It is, however, much more difficult, if not impossible, to detect the presence of other siccative oils, such as those of poppy and hemp. Animal oils can be detected by their odor, as also by the addition of a mixture of nitric and sulphuric acids, which give an intense red coloration with fish oil. The adulteration with mineral oils and resins can be readily discovered by the process of saponification, when these substances rise to the surface.

* By the "saponification number" is meant the number of milligrms. of KHO required to saponify 1 grm. of oil.

In conclusion, the authors give an historical account of the investigations of other writers and discuss the results obtained.

Oil of Pine.—The seeds of various species of conifers contain a fatty oil which is used in commerce, though not found in any large quantity. Then the seeds of *Pinus sylvestris* contain 25—30 per cent. of a brownish yellow oil, possessing to a slight degree the odor and taste of turpentine, it is used in the manufacture of varnishes and as a combustible. The oil is very sparingly soluble, even in boiling alcohol; it dries very slowly. The following data are given:

Specific gravity at 15° C.		0·9215
Point of solidification.		—18° C.
Fatty acids	Point of fusion.	17°—19° C.
	" solidification	10°—16° C.
Iodine number		118·9—120·06
" "	of fatty acids.	121·5
Saponification number.		191·27

The oil gives an orange red coloration with Heydenreich and Brullé's reagents, and a rose with Hauchecorne's reagent.

Oil of Grape Seed.—In order to extract this oil, grape seeds are air-dried, crushed and pulverized, and then subjected to pressure; its production is practiced in some parts of Germany, France, and also Italy; the yield varies from 10 to 20 per cent., according to the quality of the grape, method of culture, climate, and other conditions. The oil is of a bright yellow color, turning brown after some time; on exposure it slowly becomes rancid; it is readily soluble in its own volume of glacial acetic acid at 70°, moderately soluble in alcohol.

Horn (Staz. agrarie 22, 217) has recently shown that this oil resembles castor oil, and may probably be substituted for it in the making of Turkey red oils. The following data are given:

Specific gravity at 15° C.		0·936
Point of solidification.		—10° C. to—12° C.
Fatty acids	Point of fusion.	23°—25° C.
	" solidification	18°—20° C.
Temperature rise.		52° C.
Iodine number.		65·8
" "	of fatty acids.	98·9
Saponification number.		178·5

The oil gives an intense orange coloration with Brulle's and Hauchecorne's reagents, and a reddish yellow with that of Heydenreich.

The saponification number resembles that of the oils from the *Cruciferæ* in being very low. The oil in question also resembles these oils in containing the glyceride of erucic acid.

Butter of Cacao.—The butter of the cacao (*Theobroma cacao*) is now generally obtained as a by-product in the manufacture of chocolate. It is of a yellowish white color, unctuous to the touch, soluble in ether, benzene and acetic acid; it consists of the glycerides of stearic, oleic, palmitic, and arachidic acids. The following data are given:

Point of fusion.		28°—30° C.
" solidification.		21·5°—23° C.
Fatty acids	Point of fusion	48°—50° C.
	" solidification	45°—47° C.
Iodine number.		36—62
" "	of fatty acids.	39—1
Saponification number.		193·55

Cacao butter is frequently adulterated with animal fat, stearic acid, soap, wax, paraffin, and oil of almonds. The presence of paraffin can readily be ascertained by saponifying with alcoholic potash, and then warming with acetic anhydride, when the paraffin rises to the surface and solidifies on cooling.

Stearic acid can be estimated by the ordinary process of alkalimetry, using phenolphthalein as an indicator, the slight acidity of the butter not introducing any serious error. The presence of soaps and animal fats can best be recognized by the methods proposed by Björkland and Hager, the latter of whom has also devised a convenient process for the separation of the butters of the cacao and cocoa nut by the greater solubility of the latter in various solvents, such as amyl alcohol and petroleum.

Oil of Maize.—In the manufacture of alcohol from maize the seeds are first subjected to saccharification, the germs removed, and the oil extracted from them by pressure; a further quantity is also extracted from the vinasses. Thus obtained the oil is of a golden yellow color, without taste or odor; it is composed of olein, palmitin, and stearin, besides a small quantity of an ethereal oil. It has been recommended by Heinitsh as a substitute for olive oil in the preparation of ammoniacal and lead liniments and of ointments. The following data are given:

Specific gravity at 15° C.		0·9218
Fatty acids	Point of fusion.	18°—20° C.
	" solidification	13°—16° C.
Temperature rise.		84° C.
Iodine number.		112·1
Saponification.		190·1

The oil gives an orange coloration with Heydenreich's and Brullé's reagents and a red with Hauchecorne's reagent.

Oil of Poppy Seed.—Poppy seeds contain from 50—60 per cent. of oil, 30—40 per cent. being extracted in the first operation of pressure (*huile blanche*) and 22—25 per cent. in the second (*huile rouge*). The former is used as an article of food, especially in the north of France and some districts of Germany.

The following data are given, which are practically identical with those of former observers:

Specific gravity at 15° C.		0·927
Point of fusion of fatty acids.		20°—21° C.
Temperature rise.		87°—88·5° C.
Iodine number		136 82—137·55
" "	of fatty acids	139
Saponification number.		193·4—193·8

The oil gives an orange color with Brullé's reagent, a reddish brown with that of Heydenreich, and a dirty yellow with that of Hauchecorne.

The authors criticise the various methods which have been proposed to detect the sophistication of olive oil with poppy seed oil, which is frequently practiced in France; they conclude, however, that the method and reactions proposed are far from being

specially characteristic of the poppy as distinguished from other siccative and seed oils in general.

Butter of Cocoa Nut.—Cocoa nut butter is put upon the market either under its own name or as *vegetaline* and *lactine;* it is used for the adulteration of cacao butter and of milk butter. To avoid the tendency to become rancid cocoa nut butter is digested with alcohol and animal charcoal by the method proposed by Schlenk; it consists mainly of the glycerides of caproic, caprylic, palmitic, and stearic acids. It is white or slightly yellow, soluble in ether, chloroform, and boiling alcohol, readily saponified by alcoholic potash, and the soap can be salted out.

The following data are given, which do not differ greatly from those of previous observers:

Point of fusion		23°—28° C.
" solidification		14°—20° C.
Fatty acids	Point of fusion	25°—27° C.
	" solidification	16°—18° C.
Iodine number		8—8·5
" " of fatty acids		8·62—8·93
Saponification number		253·3—262

The butter gives yellow colorations with the reagents of Heydenreich, Hauchecorne, and Brullé, but no reactions with those of Bechi, Baudouin, etc.

The adulteration of ordinary with cocoa nut butter is detected by the number of Reichert, since the proportion of volatile fatty acids in the latter is very small compared with that in the former; the oleo refractometer and the solubility in acetic acid methods have also been applied. On the other hand, the oil of the cocoa nut (coprah) is adulterated with fatty animal oils; it is, however, easy to detect this fraud by the point of fusion, the iodine and saponification numbers, as also by the solubility in alcohol. Adulteration with seed oils can be detected by the iodine number and the reagents of Hauchecorne and Brullé, while those of Bechi and Baudouin serve especially to detect the presence of cotton seed and sesamé oils.—*De Negri and Fabris; Ann. del Lab. Chim. Centr. delle Gabelli.*

THE SOURCE OF THE OXYGEN IN AIR.

DR. T. L. PHIPSON, whose speculations concerning the state of the earth's atmosphere during the coal period have been mentioned before in these columns, has contributed to the *Chemical News* a statement, which he probably intends to be conclusive, respecting the way in which oxygen appeared in the atmosphere after the period in question. Dr. Phipson has exposed plants in atmospheres of carbonic acid and of hydrogen, and found that they were not killed. In the next place, he exposed them in pure nitrogen, and in a mixture of nitrogen and carbonic acid. In both cases, vegetation was remarkably healthy, and even luxuriant, for a lengthened period. To give the results of these observations in as few words as possible, Dr. Phipson states that the plant absorbs carbonic acid by the roots, and secretes oxygen by the leaves; so that after awhile the nitrogen atmosphere contains a certain quantity of oxygen, and in time it would, no doubt, approach the composition of ordinary atmospheric air. Going back to the primitive ages of the globe, he declares that there was probably a period when the heat was so intense that no compounds could exist. As the temperature fell, all kinds of compounds were formed according to the laws of affinity, until finally there remained surrounding the solidified surface of the earth an atmosphere of the inert nitrogen—a substance which is known to have little or no tendency to combine directly with other substances. That there was no oxygen in this ancient atmosphere is evident, according to Koene, from the presence of various oxidizable substances in the primitive rocks. It is into this primitive atmosphere of nitrogen that plants have poured oxygen for countless myriads of years, until it has arrived at its present composition. There was doubtless more carbonic acid in the atmosphere of the earth during the coal period, due to the abundance of volcanic action; but it is not necessary to refer the exuberance of the vegetation of that particular era to the presence of this gas, because vegetation of certain orders is able to flourish luxuriantly in nitrogen alone.

PYROXYLINE SOLVENTS.

L. PAGET'S invention relates to new series of solvents for pyroxyline. The patentee claims to have discovered that, by distilling mixtures of primary alcohols (not necessarily themselves solvents of pyroxyline) with sulphuric acid and a suitable organic acid (such as acetic or salicylic acid), mixed compound ethers are produced which are exceedingly good solvents and diluents of pyroxyline, and, moreover, are different from simple mixtures of the corresponding compound ethers. Thus, for instance, when 25 parts by weight of ethyl alcohol, 30 to 25 parts of amyl alcohol, 25 parts of sulphuric acid, and 12½ parts of acetic acid are heated together and distilled, a product is obtained which is an exceedingly good solvent for pyroxyline, and is, moreover, distinct in its properties from a mixture of ethyl and amyl acetates.

Similarly he claims, by the etherification of mixtures of two, three, or more primary alcohols by means of sulphuric acid, to produce substances of good solvent power and differing from mixtures of the corresponding simple ethers. If these products are again distilled with glacial acetic acid, or with a mixture of sulphuric acid with a suitable organic acid, another new series of solvents and diluents of solutions of pyroxyline is obtained.

By careful selection of the alcohols and acids employed the properties and volatility of the products may be modified and varied as desired.

ALCOHOL FROM PEAT.

THE convertibility of cellulose into sugar admits of its being made a source of alcohol, and attempts have been made to produce alcohol from wood in this way. The compact texture of wood has, however, proved an obstacle by which the cost of production was rendered too great for the practical adoption of the method. Quite recently it is reported that a more successful result has been obtained by operating upon cellulose of a naturally more open texture as it occurs in peat moss. For this purpose the turf is heated to 115° to 120° C. with dilute sulphuric acid for four or five hours to convert the cellulose into sugar, and when the full effect has been produced the expressed liquor is fermented with yeast and afterward submitted to distillation. It is stated that in this way turf is likely to compete favorably with potatoes as a source of alcohol, 1,000 kilos. of dry turf yielding from 62 to 63 liters of absolute alcohol, while 500 kilos. of potatoes containing 20 per cent. of starch yield at the utmost only 60 to 61 liters of absolute alcohol.—*Pharm. Jour.*

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